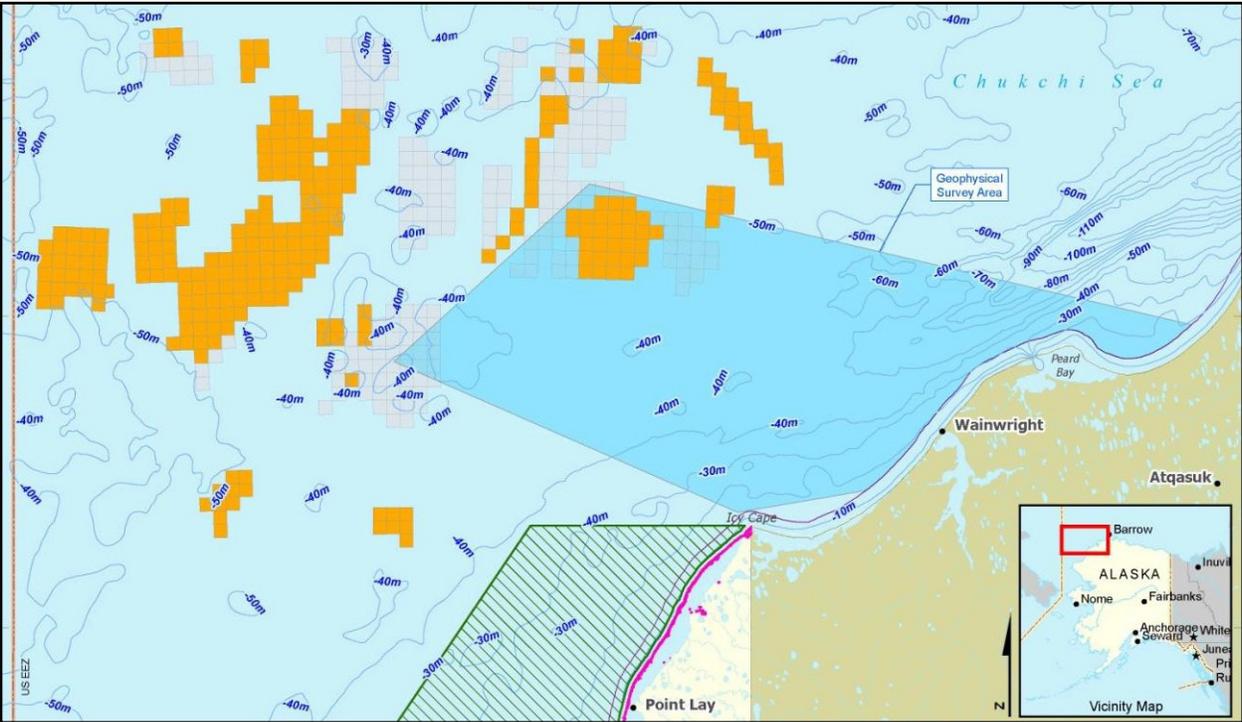




Shell 2013 Ancillary Activities Survey Chukchi Sea, Alaska

ENVIRONMENTAL ASSESSMENT

Prepared By:
Office of Environment
Alaska OCS Region



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Acronyms and Abbreviations

~	Approximately
AAC	Alaska Administrative Code
ACIA	Arctic Climate Impact Assessment
ACP	Arctic Coastal Plain
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
AEWC	Alaska Eskimo Whaling Commission
AFMP	Arctic Fishery Management Plan
AO	Arctic Oscillation
AQCR	Air Quality Control Regions
bbl	Barrel/Barrels
BOD	Biological Oxygen Demand
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
CAA	Clean Air Act or Conflict Avoidance Agreement
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO	carbon monoxide
COMIDA	Chukchi Offshore Monitoring in Drilling Area
CWA	Clean Water Act
dB re 1 μ Pa	Decibels in Relation to a Reference Pressure of 1 Micropascal
DPP	Development and Production Plan
EA	Environmental Assessment
EEZ	U.S. Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EJ	Environmental Justice
EP	Exploration Plan
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FLIR	Forward Looking Infrared (a forward looking thermal imaging camera system)
FMP	Fishery Management Plan
FONSI	Finding of No Significant Impact
FR	Federal Register
G&G	Geological and Geophysical
hr	Hour
Hz	Hertz
IHA	Incidental Harassment Authorization
in	Inch
ION	ION Geophysical, Inc.
IPCC	Intergovernmental Panel on Climate Change
ITA	Incidental Take Authorization
IWC	International Whaling Commission
kt	Nautical Mile Per Hour (1 Knot = 1.853 Km/H)
kW	Kilowatt
Lease Sale 193	Chukchi Sea OCS Oil and Gas Lease Sale 193
LOA	Letter of Authorization
m	Meter
min	Minute
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
M/V	Marine Vessel
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act

NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NMML.....	National Marine Mammal Laboratory
NO ₂	Nitrogen Dioxide
NOAA	National Oceanic and Atmospheric Administration
NO _x	Nitrogen Oxides
NPDES	National Pollutant Discharge Elimination System
NPFMC	North Pacific Fisheries Management Council
NSB	North Slope Borough
OCSLA.....	Outer Continental Shelf Lands Act
OCS	Outer Continental Shelf
PEA	Programmatic Environmental Assessment
PM	Particulate Matter
PSD.....	Prevention of Significant Deterioration
psi	Pounds Per Square Inch
PSO.....	Protected Species Observer
s	Second
SBS.....	Southern Beaufort Sea Stock of Polar Bears
SEIS.....	Supplemental Environmental Impact Statement
SHPO.....	State Historic Preservation Office
SO ₂	Sulfur Dioxide
TTS.....	Temporary Threshold Shift
U.S.....	United States of America
USC.....	United States Code
USDOC	U.S. Department of Commerce
USDOJ.....	U.S. Department of the Interior
USFWS.....	U.S. Fish and Wildlife Service
USGS.....	United States Geological Survey
VOC.....	Volatile Organic Compounds
VGP	Vessel General Permit

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1.0 INTRODUCTION

On April 19, 2013, Shell Gulf of Mexico Inc. (Shell), under 30 Code of Federal Regulation (CFR) 550.208, provided an Ancillary Activity Notice to the U.S. Department of the Interior, Bureau of Ocean Energy Management (BOEM) to complete an open water marine survey program in the Chukchi Sea during 2013. This Notice replaces the Notice previously submitted by Shell to BOEM on February 12, 2013 for similar activities.

1.1. Purpose of the Noticed Activity

The purpose of the Noticed Activities is to conduct geophysical surveys (aka open water marine surveys) designed to gather additional data relative to ice gouge (Figure 1) and shallow hazards (Figure 2) in select offshore areas of the Chukchi Sea.

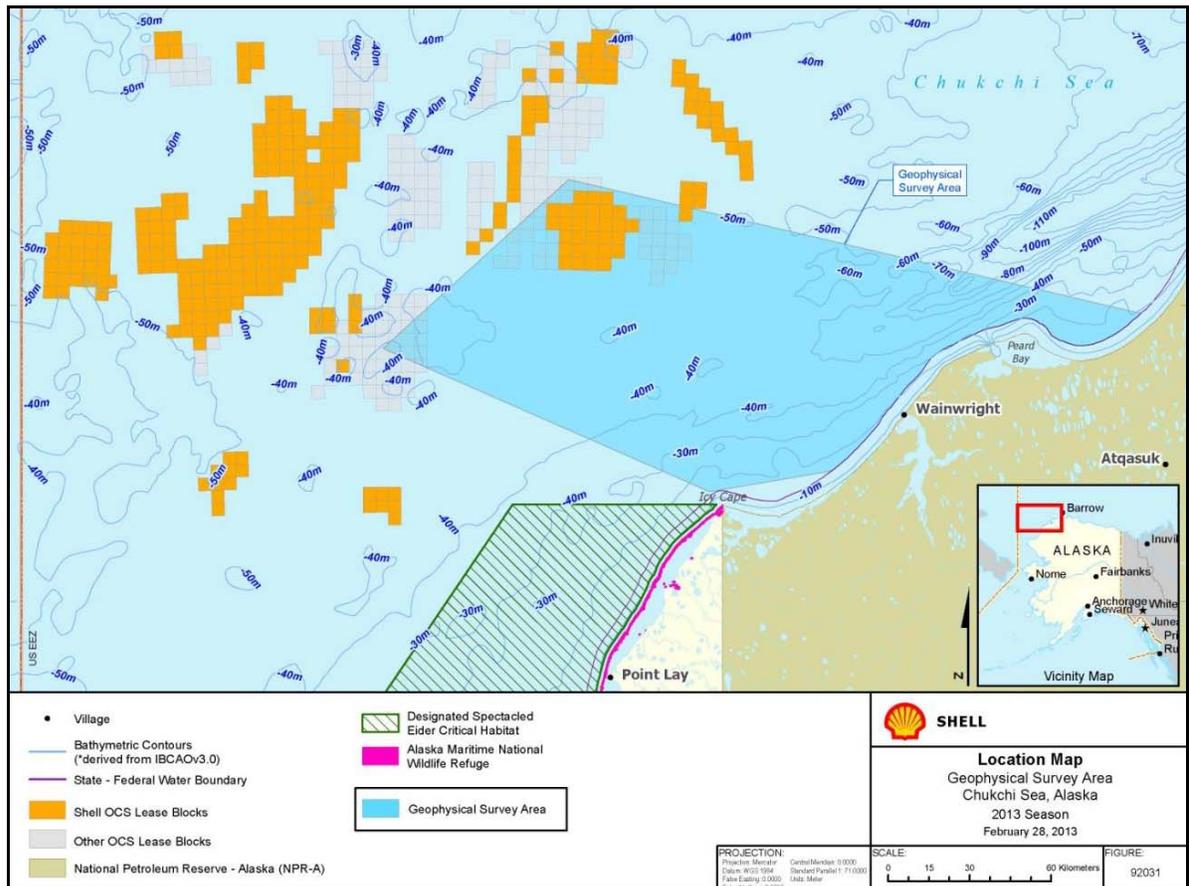


Figure 1. Location of the 2013 Chukchi Sea Offshore Ice Gouge Surveys.

Shell's planned surveys will support future exploration activities by generating data necessary to evaluate the physical environment in the vicinity of their ongoing Chukchi Sea exploration program, and thus identify possible future location of facilities. Offshore ice gouge surveys investigate the depth, width, orientation, frequency, and distribution of ice gouges and will profile the seafloor surface as well as gain important bathymetric data. Site clearance and shallow hazards surveys characterize the upper 3,128 ft (1,000 m) of sub-seafloor sediments. Both of these surveys are focused on limited areas to characterize the seafloor and shallow seafloor sediments at prospective drilling locations and along potential pipeline routes.

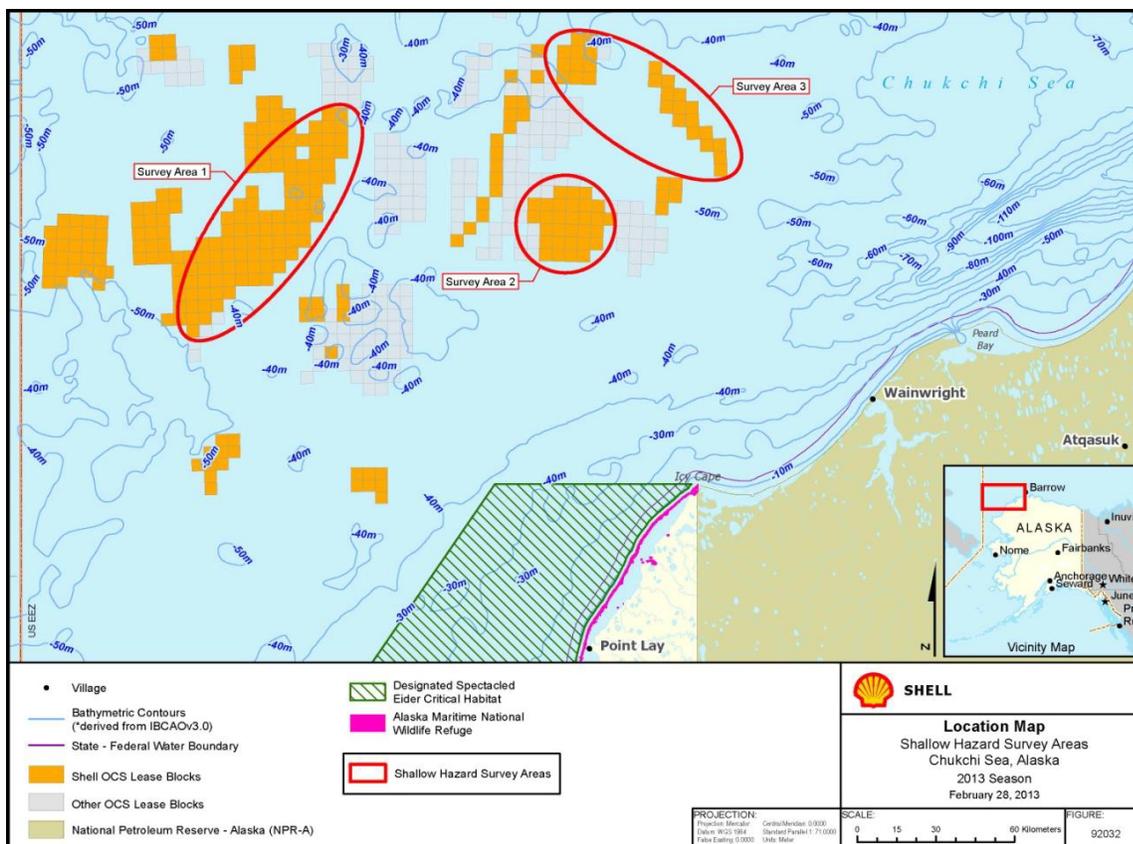


Figure 2. Location of the 2013 Chukchi Sea Site Clearance and Shallow Hazards Surveys (Survey Area 1: Crackerjack; Survey Area 2: Burger; Survey Area 3: Northeast of Burger).

Per regulations at 30 CFR 550.207 these types of geophysical surveys are considered ancillary activities. A permit is not required from the Bureau of Ocean Energy Management (BOEM) for ancillary activities (30 CFR 550.105); however, prior to authorizing the activities, BOEM requires notification by the operator at least 30 days in advance of the planned surveys (30 CFR § 550.208). Upon receipt of the requisite notice, BOEM reviews the notice to ensure that the ancillary activities comply with the performance standards listed in 550.202(a), (b), (c) and (e).

BOEM has prepared this Environmental Assessment (EA) to determine if Noticed Activities interfere with other uses of the OCS or cause undue or serious harm or damage to the human, marine, or coastal environment (30 CFR 250.2(d) and (e)).

1.2. Previous Applicable Analyses

The BOEM has completed numerous NEPA reviews of Beaufort Sea and Chukchi Sea OCS activities. NEPA reviews and other analyses that are relevant to the Noticed Activities and/or the Noticed Activities area include the following:

- Environmental Assessment – ION Geophysical 2012 Seismic Survey Beaufort Sea and Chukchi Sea, Alaska (OCS EIS/EA BOEM 2012-081) October 2012 (USDOJ, BOEM, 2012) (hereafter “2012 ION Seismic Survey EA”).
- Environmental Assessment - Shell Gulf of Mexico, Inc., 2012 Revised Outer Continental Shelf Lease Exploration Plan, Chukchi Sea, Burger Prospect, Alaska. (OCS EIS/EA BOEM 2011-061) (USDOJ, BOEM, 2011a) (hereafter “2012 Shell Chukchi Sea EP EA”).

- Final Supplemental Environmental Impact Statement, Chukchi Sea Planning Area, Oil and Gas Lease Sale 193 (OCS EIS/EA BOEMRE 2011-041) 2011 (USDOJ, BOEMRE, 2011b) hereafter “Lease Sale 193 Final SEIS”).
- Final Environmental Impact Statement, Chukchi Sea Planning Area Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea (OCS EIS/EA MMS 2007-026) May 2007 (USDOJ, MMS, 2007) (hereafter “Lease Sale 193 and Seismic Surveying EIS”).
- Final Programmatic Environmental Assessment, Arctic Ocean Outer Continental Shelf, Seismic Surveys – 2006 (OCS EIS/EA MMS 2006-038) June 2006 (USDOJ, MMS, 2006) (hereafter “2006 Seismic PEA”).

The EA and EIS documents above are available on the BOEM Alaska website at: <http://www.boem.gov/ak-eis-ea/>. This EA builds upon these previous analyses by analyzing site- and project-specific information, and by incorporating new information from recent scientific studies. The EA also considers information and analysis submitted by Shell. BOEM reviewed Shell’s submitted documents and, consistent with 40 CFR 1506.5(a), BOEM independently evaluated the applicant's analysis and supplemented it where necessary.

This EA considers and incorporates relevant data and issues raised during the public comment period from May 22, 2013, to midnight June 05, 2013. Further information is available at Section 4.5, Public Involvement.

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2.0 ALTERNATIVES

2.1. Summary of Alternatives

This Environmental Assessment (EA) examines the following alternatives:

Alternative 1 - No Action. Shell does not conduct ancillary activities in the Chukchi Sea during the open water season in 2013.

Alternative 2 – Noticed Activities. Shell conducts the following types of surveys in offshore federal waters in the Chukchi Sea during the open water season in 2013:

- Approximately 621 mi (1,000 km) of ice gouge surveys
- Approximately 1,988 mi (3,200 km) of Site Clearance and Shallow Hazards surveys

2.2. Description of the Alternatives

2.2.1. Alternative 1 – No Action

2.2.2. Alternative 2 - Shell conducts an open water marine survey in the Chukchi Sea during 2013.

2.2.2.1. Overview

Shell plans to conduct the following types of surveys in offshore federal waters in the Chukchi Sea during the open water season in 2013:

- Offshore Ice Gouge Surveys approximately 621 mi (1,000 km) of ice gouge surveys
- Site Clearance and Shallow Hazards Surveys total of approximately 1,988 mi (3,200 km) of tracklines in three survey areas

The surveys will be conducted within the portions of the Chukchi Sea indicated in Figures 1.0-1 and 1.0-2 in mid-July to mid-October 2013. The offshore ice gouge surveys and the site clearance and shallow hazards surveys will be conducted from the same survey vessel, the MSV *Fennica*.

For more information on the Noticed Activity, refer to page 2-1 of the “Shell Chukchi Sea 2013 Ancillary Activity Notice Open Water Survey Program,” found at http://www.boem.gov/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Leasing_and_Plans/Plans/2013-04-19%20Shell%20Chukchi%20Sea%202013%20Ancillary%20Activity%20Notice%20Open%20Water%20M...pdf

2.2.2.2. Additional Plan Components

Some of the additional mitigation measures Shell has adopted and implements during its Chukchi Sea exploration drilling operations, and are relevant to an open water marine survey program, are listed below. These mitigation measures reflect Shell’s experience conducting exploration drilling in Alaska since 1986 and its ongoing consultations with local subsistence communities to better understand their concerns and develop appropriate and effective mitigation measures to address those concerns. Aircraft are not expressly proposed to support the marine surveys program; however, in the remote chance aircraft, fixed-wing or rotary-winged, are used to support or assist an operation of these surveys, the aircraft travel mitigation measures have been included.

2.2.2.2.1. Communications

Shell has developed a Communication Plan with local subsistence users, as well as Village Whaling Captains’ Associations, to minimize the risk of interfering with subsistence hunting activities, and

keep current as to the timing and status of the bowhead whale hunt and other subsistence hunts. Shell will implement this plan before initiating the Noticed Activities. The Communication Plan includes procedures for coordination with Communication Centers (Com Centers) to be located in coastal villages along the Chukchi Sea during Shell's noticed marine surveys. Shell will employ local Subsistence Advisors (SAs) from the Chukchi Sea villages that could potentially be impacted by the Noticed Activities. The SAs will provide consultation and guidance regarding the whale migration, subsistence activities concerns or conflicts; coordinate with subsistence users; report subsistence-related comments, and advise on subsistence conflicts avoidance.

2.2.2.2.2. Airgun Array Operation

Airgun arrays will be ramped up slowly during the site clearance and shallow hazards surveys to warn cetaceans and pinnipeds in the vicinity of the airguns and provide time for them to leave the area and avoid potential injury or impairment of their hearing abilities. Ramp ups from a cold start when no airguns have been firing will begin by firing a single airgun in the array (i.e., the mitigation airgun). A full ramp up, after a shutdown, to the required airgun array volume will not begin until the Protected Species Observers (PSOs) have observed the safety zone for a minimum of 30 minutes to assure that no marine mammals are present. The safety zone is the extent of the 180 dB radius for cetaceans and 190 dB for pinnipeds. The entire safety zone must be visible during the 30-minute lead-in to an array ramp up. If a marine mammal(s) is sighted within the safety zone during the 30-minute watch prior to ramp up, ramp up will be delayed until the marine mammal(s) is sighted outside of the safety zone or the animal(s) is not sighted for at least 15-30 minutes: 15 minutes for small odontocetes and pinnipeds, or 30 min for baleen whales and large odontocetes.

2.2.2.2.3. Aircraft Travel

Aircraft, will not operate below 1,500 ft (457 m) unless the aircraft is engaged in approach, landing or taking off, in poor weather (fog or low ceilings), or in an emergency situation to minimize disturbance to mammals and birds.

Aircraft will not operate within 0.5 mi (0.8 km) of walrus or polar bears observed on land, ice, or in the water.

No rotary winged aircraft will operate at an altitude lower than 3,000 ft (914 m) within 1 mi (1.6 km) of walrus groups observed on land.

2.2.2.2.4. Vessel Travel

The vessel will enter the Chukchi Sea through the Bering Strait after July 1st, minimizing effects on marine mammals and birds that frequent open leads and minimizing effects on spring and early summer bowhead whale hunting.

The transit route for the vessel through the Chukchi Sea will avoid the Ledyard Bay Critical Habitat Unit (LBCHU) and will include coordination through Com Centers.

PSOs will be aboard the survey vessel.

The survey vessel will not operate within 0.5 mi (0.8 km) of walrus or polar bears when observed on ice and in the water; 0.5 mi (0.8 km) of polar bears on land; and 1 mi (1.6 km) of groups of walruses when observed on land.

Vessel speed is to be reduced during inclement weather conditions in order to avoid collisions with marine mammals.

When within 900 ft (274 m) of whales, the vessel will reduce speed to at least 5 knots, avoid separating members from a group and avoid multiple changes in direction.

The survey vessel will take all practical measures (i.e., reduce speed, change headings) to maintain a minimum 0.5 mi (0.8 km) operational exclusion zone around groups of 12 or more walrus encountered in the water. The vessel may not be operated in such a way as to separate members of a group of walrus.

Shell will communicate and coordinate with the Com Centers regarding all vessel transit.

2.2.2.2.5. Additional Information

To ensure compliance with the Marine Mammal Protection Act (MMPA), Shell has applied to NMFS and USFWS for authorization for the incidental take of marine mammals under the MMPA. Receipt of the authorizations before commencing seismic-survey activities will be required by BOEM. The mitigation and monitoring requirements in these ITAs will further ensure that potential impacts to marine mammals will be negligible and that there will be no unmitigable impacts to the availability of subsistence resources.

• Marine Birds Lease Sale Stipulation 7

The following information on potential operations in Ledyard Bay Critical Habitat Unit (LBCHU) is provided in this document in order to accommodate Shell's planned 2013 operations.

An integral part of the Shell Ancillary Activity Notice is the Marine Mammal Monitoring and Mitigation Plan (4MP) for Open Water Marine Surveys and Equipment Recovery and Maintenance, Alaskan Chukchi Sea, 2013 (Appendix C). Page 15 of the 4MP indicates that Shell's 2013 program plans include the deployment/retrieval of passive acoustic monitoring (PAM or AMAR) devices in LBCHU, which is outside of the lease sale area (page 15 of the 4MP).

According to Lease Sale 193 Stipulation 7, no Shell operations may take place in the Ledyard Bay Critical Habitat Unit (LBCHU), an area important to spectacled eiders. The only exception for Shell vessels to enter the LBCHU is for reportable marine casualties as defined in 46 CFR 4.05-1 or hazardous conditions as defined by 33 CFR 160.204.

The BOEMRE September 30, 2011, Biological Evaluation indicated to the USFWS that any exceptions to Lease Sale 193 Stipulation 7 would be consulted upon on a case-by-case basis. In this instance, BOEM has consulted with USFWS on the potential for Shell and its contractors to enter the LBCHU during the 2013 open water season.

Consistent with this consultation, in the event of entry into the LBCHU during the 2013 season by Shell, its contractors, permittees and agents of Shell's lessees and permittees, the following terms will apply:

- The AMAR deployment/retrieval vessel will enter the LBCHU from an offshore location and will sail perpendicular to the coast, following the shortest route possible to reach the AMAR locations. After deployment or retrieval is completed, the vessel will retrace a similar trackline to exit the LBCHU.
- Deployments and retrievals will include a trained seabird observer on the bridge who will conduct surveys for eiders (and other seabirds, if possible) and who will direct the ship's Master to avoid flocks of eiders. This observer will be on watch during all daylight hours.
- The vessel will match the speed to the request of the seabird observer's ability to scan for birds. The ship's speed will be approximately 8 kts.
- If vessels encounter a flock of eiders along the proposed path, the vessel will divert around the birds to avoid unnecessary disturbance. The vessel should maintain a steady vessel speed to the right or left of the flock to allow the flock to adjust location, if necessary.

- The presence of eiders, including location and group size by species (if obtained without disturbance) will be reported BSEE- Environmental Enforcement Division (BSEE-EED) and BOEM, Resource Evaluation Office (BOEM-RE) within 3 days of each entry into the LBCHU. These reports will summarize dates and times of activities, numbers and locations of eiders recorded, and actions taken to minimize impacts to eiders.

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

Section 3.1 summarizes the environmental conditions of the Noticed Activity. Section 3.2 evaluates particular marine resources and the affects the Noticed Activity is expected to have on them.

3.1. Expected Operating Conditions

The North Slope of Alaska, adjacent to the Chukchi Sea and the Beaufort Sea, is classified as a polar tundra climate characterized by moderate winds, cold temperatures during the winter, cool temperatures in the summer, and little annual precipitation (Ahrens, 2009). The region is dominated by subfreezing temperatures for most of the year, and the area is almost totally ice covered from early December to mid-May. During the fall and winter months, winds can be strong and prolonged, leading to extreme ice pressures and dangerous wind-chill conditions. Winds over the Chukchi Sea are more northwesterly in the autumn and winter months. Following a brief warm and snow-free season during June, July, and August, temperatures will fall sharply, skies will be partly cloudy, and precipitation will decrease gradually throughout the period from October through December.

3.1.1. Climate Change

The continued loss of sea-ice, already determined to be occurring in the Arctic, could increase the presence of internal ocean waves bringing deep waters that are rich in nutrients to the surface. These and other effects of climate change are considered in the discussion of existing conditions, and effects by and on the Noticed Activity for the several environmental resources are included in this environmental review.

3.1.2. Meteorology

The Shell Noticed Activity would occur from mid-July through mid-October 2013, in the Chukchi Sea OCS. The average temperature in July will range from 34 degrees Fahrenheit (°F) to 52°F decreasing to 11°F to 21°F by October. The record low temperatures in October have been as low as -19 to -32°F. Most of the annual precipitation falls in the summer with an average of 2.35 inches falling in each month of July and August and 1.56 inches in each month of September and October (WRCC, 2012). The average wind speed can be expected to be 6-11 miles per hour generally from the northeast. When considering the average wind speeds and temperatures common to the North Slope, daily wind chills will likely be 27°F in the months of July and August decreasing to -4°F by late October. Occasional sudden storms can occur and the lack of natural wind barriers can result in unrestricted winds. These storms bring cold temperatures and occur most frequently between September and November. The combined effect of cold temperatures and strong winds during storms makes the North Slope a wind-chill risk to persons exposed to outside conditions for even brief periods of time. In extreme cases the wind chill could drop as low as -41°F in October.

3.1.3. Ice Conditions

The sea-ice and sea state description in sections III.A.2 and III.A.4 of the Lease Sale 193 and Seismic Surveying EIS (USDOJ, MMS, 2007) and Sale 193 Final SEIS (USDOJ, BOEMRE, 2011) are summarized and incorporated by reference. Salient points from these documents are summarized as follows. There are three general forms of sea ice in the project area (including the nearshore areas): (1) landfast ice, which is attached to the shore, is relatively immobile, and extends to variable distances offshore; (2) stamukhi ice, which is grounded and ridged ice; and (3) pack ice, which includes first-year and multiyear ice and moves under the influence of winds and currents.

The Noticed Activity is planned for the Arctic “open-water” season during summer and early fall (Mahoney et al. 2012, Leidersdorf, Scott and Vaudrey, 2012). The Noticed Activity location is

seaward of the typical extent of landfast ice during the time of operations. From 1993-2010 the formation of lagoon fast ice generally commenced during the first two weeks in October. From Cape Lisburne to Peard Bay first landfast ice ranged from late October to late January (Mahoney et al. 2012). Stamukhi ice is not anticipated in the project area at the time of operations. Pack ice could move into the project area during the time of operations due to wind or currents.

3.1.4. Sea State

East northeast winds predominate in Chukchi Sea in July-October with a frequency of 40-60% and the scalar mean wind speed ranges from 2 to 9 meters per second (m/s) (Brower et al., 1988; Weinzapfel et al., 2011; Stegall and Zhang, 2012). With the onset of ice cover in November, wave height diminishes and is generally < 1.5 m (Brower et al., 1988).

Stegall and Zhang (2012) noted increasing trends of areal averaged monthly mean and 95th percentile wind speeds for July through November. October had the strongest increase in the areal averaged wind speeds from 7 m/s in 1979 to 10.5 m/s in 2009. The frequency of extreme wind events shows an increasing trend with October, showing 8% more extreme wind events in 2009 compared to 1979 (Stegall and Zhang, 2012).

3.2. Alternative 1 – No Action

3.2.1. Alternative 1 Direct and Indirect Effects

Under Alternative 1 – No Action, Shell’s Noticed Activity would not occur. Shell would not gather additional data relative to ice gouge and shallow hazards in select offshore areas of the Chukchi Sea. This could result in delayed or lost opportunities to develop the lease, which does not meet the regulatory mandate of Outer Continental Shelf Lands Act (OCSLA) (43 USC 1332), which states that: “the outer Continental Shelf is a vital national resource reserve held by the Federal Government for the public, which should be made available for expeditious and orderly development, subject to environmental safeguards, in a manner which is consistent with the maintenance of competition and other national needs.”

Under Alternative 1 –No Action, there would be no disturbance attributable to the Noticed Activity to any resources described in Section 3.0. There would then be no seismic survey effects on air or water quality, fish, lower trophic populations, marine and coastal birds, marine mammals, or accessibility of marine mammals for subsistence activities.

3.2.2. Alternative 1 Cumulative Effects

The Arctic Ocean ecosystem is rapidly changing, with melting sea ice and increasing sediment input from numerous regional river systems. Open-water seasons are longer than in years past, allowing for increased sunlight and a reduction in multi-year ice. Activities currently ongoing in the U.S. Arctic region or which may occur in the foreseeable future and affect OCS resources include: increased marine vessel and air traffic, fuel and petroleum spills, permitted and non-permitted discharges, long-distance aerosol-transported pollutants, climate warming, sea ice melting, ocean acidification, and risk of invasive species from ship hulls and deployed equipment. Specific activities known to be scheduled to occur during 2013 are summarized and included in Appendix B, Cumulative Effects Scenario, of this EA.

The 2006 Seismic PEA and the Lease Sale 193 SEIS provide detailed descriptions of past activities, reasonably foreseeable future activities, and the environmental consequences of these activities in the Beaufort Sea and Chukchi Sea. If the Noticed Activity does not take place, no additional effects would be added to the effects associated with ongoing or reasonably foreseeable future activities in the Beaufort Sea or Chukchi Sea.

3.3. Alternative 2 Affected Environment and Impacts

Each alternative is analyzed for direct and indirect effects to identified resources. The analysis also identifies, where appropriate, mitigation that could be used to limit adverse effects. Potential cumulative effects are then discussed under each resource category. Each cumulative effects subsection considers past, present, and reasonably foreseeable actions that could affect each resource, and analyzes the potential for the Noticed Activities to contribute incrementally to these impacts. The cumulative effects scenario (past, present, and reasonably foreseeable activities in the Noticed Activity area) is presented in Appendix B. The cumulative effects analyses tier from the cumulative effects analyses in the previous, broader-scope NEPA documents cited in Section 1.3.

The scope of this assessment includes the incremental impact from the action alternatives plus the aggregate effects of other activities that are known to occur or that can be reasonably expected to occur at the same time as, and in the vicinity of the Noticed Activities, and which have a potential to affect the same resources as the Noticed Activities. Therefore, the duration and geographic scope of a Noticed Activities are critical in determining what other past, present, and reasonably foreseeable future actions are relevant to the cumulative effects analysis for each affected resource. The noticed activity by Shell Exploration will occur in an approximately 2500 mile area in the Chukchi Sea, and will occur over an approximate 60 day period between July 15 and October 15. To the extent that effects for a given resource are temporary and local to this area, these effects are not likely to add incrementally to other actions occurring outside of the area (e.g. Russia) or outside of that timeframe. Cumulative effects analysis in this EA reflects consideration of these constraints specific to each resource.

A level of effect determination (i.e., negligible, minor, moderate, or major) is provided for each resource under the description of impacts, followed by a discussion of cumulative impacts for each resource. Appendix A describes the various levels of effect for each resource.

Invasive Species

An “invasive species” is defined as “a species whose introduction does or is likely to cause economic or environmental harm or harm to human health where it is introduced” (Executive Order 13112 of February 3, 1999: *Invasive Species*). Potential vectors for introducing aquatic invasive species are ballast-water discharge, fouled ship hulls, and equipment placed overboard (e.g., anchors, seismic airguns, hydrophone arrays).

The U.S. Coast Guard (USCG) regulations at 33 CFR 151 implement provisions of the National Invasive Species Act of 1996 (NISA). Vessels brought into the State of Alaska or Federal waters are subject to these USCG regulations, which are intended to reduce the transfer of invasive species. The regulations require operators to remove “fouling organisms from hull, piping, and tanks on a regular basis and dispose of any removed substances in accordance with local, State, and Federal regulations” (33 CFR 151.2035(a)(6)). The regulations, however, do not specifically call for the same removal procedures for ocean-bottom cables or seismic equipment. There is a low potential for pelagic organisms and seaweed to become entrained in equipment towed during a seismic survey (Kinloch, Summerson, and Curran, 2003). Typical organisms that are returned with the seismic streamers are jellyfish tentacles and shark teeth. These items are removed from the streamer by hand before it is rewound on the drum.

The following subsections analyze potential direct, indirect, and cumulative effects on environmental resources as a result of Alternative 2 - Noticed Activities.

Fuel Spill Analysis

No fuel transfers will occur in the Chukchi Sea as part of the Noticed Activity, and no fuel spills are estimated to occur within the project area. Therefore, no further fuel spill analysis is required in this EA.

3.3.1. Air Quality

3.3.1.1. Affected Environment

The existing condition of air quality in the vicinity of the Noticed Activity is largely a function of the few emission sources existing on the coastline of the North Slope and meteorological conditions, mainly wind, over the open sea. The offshore waters of the Chukchi Sea adjacent to the North Slope typically experience steady winds averaging 6-11 miles per hour and have periods of stronger winds, which have a tendency to disperse and mix air pollutants within the surrounding air. The stronger the wind and the more turbulent the air, the more pollutants are diluted, which decreases pollutant concentrations and reduces the environmental impact (Ahrens, 2009). The wind conditions over the project area together with the relatively few pollutant sources either onshore or offshore cause the quality of the air over the affected area to be consistently better than required by federal standards (ADEC, 2010). As such, the Environmental Protection Agency (EPA) recognizes the North Slope Borough as an area of good air quality where current concentrations of pollutants do not adversely affect human health and welfare.

3.3.1.2. Direct and Indirect Effects

The Noticed Activities on the Chukchi Sea OCS include use of the survey vessel *Fennica*. The operation of the main diesel propulsion engines on the vessel would be the primary source of emissions of regulated air pollutants as well as greenhouse gases. In addition to the main propulsion engines, emissions from the *Fennica* would occur due to operation of the auxiliary engines, bow and azimuth thrusters, boilers, an incinerator, and emissions from helicopter support services, should such services be needed. An inventory of estimated emissions was prepared to assess the effect of the Noticed Activity on air quality. A thorough examination of the vessel emissions is included in Appendix C, Air Quality, and includes the complete emission inventory.

When considering the wind conditions over the project area together with the relatively low emissions estimated to occur due to the Noticed Activity, the quality of the air over the affected area would remain better than required by Federal standards (ADEC, 2010). As such, the potential impact to air quality conditions would be negligible. The inventory evaluation shows that emissions from the vessel's various engines, together with emissions from helicopter services, would not cause emissions of any Federally-regulated pollutant to exceed the recognized threshold of 100 tons per year defining a de minimis, or negligible, source of emissions. Further, persistent moderate winds, and episodes of strong winds, which are typically found over the open waters of the Chukchi Sea, have a tendency to disperse and mix air pollutants within the surrounding ambient air. Stronger winds cause greater turbulence in the air, which decreases pollutant concentrations and reduces the environmental impact (Ahrens, 2009).

3.3.1.3. Cumulative Effects

The Noticed Activities include the use of a marine vessel for a near-future short-term time frame. However, the action may occur simultaneously with other reasonably foreseeable activities in the same region of the Chukchi Sea. Any additional activities occurring during the same time period and in the same general area requiring the use of marine vessels may contribute to the air emissions from the Noticed Activities. A thorough description of cumulative operations on the Beaufort Sea OCS is provided in Appendix B Cumulative Effects Scenario, Section B-3 Impact Sources.

The 2011 Alaska Department of Environmental Conservation (ADEC) report, *Emissions, Meteorological Data, and Air Pollutant Monitoring for Alaska's North Slope* (Section 6, Ambient Monitoring on the North Slope), provides results from the most recent air quality monitoring on the North Slope using equipment installed by industrial sources. Outside Prudhoe Bay there are few monitors, and monitors are nearly non-existent west of there. Of the eight sites, only one is outside Prudhoe Bay, which is in Wainwright. The monitors placed in Wainwright would detect and record any impacts from onshore sources of emissions, as well as impacts from vessel traffic, if present. The Wainwright monitored data, reporting during 2009 and 2010, shows concentrations of the criteria pollutants are consistently well below the National Ambient Air Quality Standards (NAAQS). The pollutant most commonly linked to vessel traffic and other combustion sources is nitrogen dioxide (NO₂). The Wainwright monitor shows average one hour average concentrations of NO₂ to be 60.2 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$), 32 percent of the NAAQS set at 188 $\mu\text{g}/\text{m}^3$; the 24-hour average concentration of coarse particulate matter (PM₁₀) is 79 $\mu\text{g}/\text{m}^3$, 53 percent of the NAAQS set at 150 $\mu\text{g}/\text{m}^3$. Concentrations of carbon monoxide are less than 10 percent of the average eight-hour standard and the other pollutants show even lower percentages.

Consequently, when considering the wind conditions over the open sea and the relative lack of emission sources associated with the Noticed Activities, additional emissions from other operations in the Chukchi Sea and onshore appear to be well diluted and dispersed. Thus, based on the information currently available concerning the recent past, present, and foreseeable future projects in the Chukchi Sea, and considering the negligible air quality impact of the Noticed Activities, only negligible to minor cumulative air quality impacts would be expected.

3.3.2. Water Quality

3.3.2.1. Affected Environment

Water quality is a term used to describe the chemical, physical, and biological characteristics of water. The majority of the water flowing into the Chukchi Sea marine environment is not subject to human activity or stressors and is considered unimpaired (ADEC, 2013).

The Chukchi Sea is fed by Pacific waters entering the Chukchi Sea via the Bering Strait in the south, and Arctic waters entering the Chukchi Sea via Long Strait. The regional throughflow in the Bering-Chukchi is large, and the flow carries large amounts of nutrients, resulting in remarkably high summer productivity on the Bering-Chukchi shelf (Woodgate, Aagaard, and Weingartner, 2005).

Temperature and salinity records show a strong annual cycle of freezing, salinization, freshening, and warming, with sizable seasonal variability. The largest seasonal variability is seen in the eastern Chukchi Sea (the region of the Noticed Activity) where warm freshwaters escape from the buoyant, coastally trapped Alaskan Coastal Current into the interior Chukchi Sea (Woodgate, Aagaard, and Weingartner, 2005).

Water on the inner shelf (<50 m) is well mixed, and temperature and salinity are uniform within a single layer most of the time. On the middle shelf (50-100 m), a two-layer temperature and salinity structure exists because of downward mixing of wind and upward mixing due to relatively strong tidal currents (Kinder and Schumacher, 1981). On the outer shelf (100-200 m), a three-layer temperature and salinity structure exists due to downward mixing by wind, horizontal mixing with oceanic water, and upward mixing from the bottom friction due to relatively strong tidal currents. Oceanic water structure is present year-round beyond the 200-m isobath.

Several natural processes alter the qualities of Chukchi Sea water including: formation and melting of sea ice, biogenic hydrocarbon concentrations, erosion of shorelines, wind mixing, and atmospheric deposition.

3.3.2.2. Direct and Indirect Effects

Certain discharges from the survey vessel would be permitted under the Vessel General Permit as administered by EPA. These permitted discharges include: deck drainage, sanitary waste, domestic waste, non-contact cooling water, brine water from desalinization, bilge water, and ballast water.

Deck drainage occurs from rainfall, sea-spray and water used to clean equipment. These waters come in contact with oil-coated deck surfaces and become contaminated. Oil and grease are the primary pollutants identified in the deck drainage waste stream. The deck wastewater is collected and treated in an oil-water separator before discharge to the sea. Deck-drainage discharges are not continuous discharges. Deck wash-downs are planned and the discharges are of relatively low volume. During rainfall, however, very large volumes of deck drainage may be discharged unexpectedly in a very short time period.

Sanitary waste is human body waste, which after treatment includes chlorinated effluent. Primary concerns in sanitary waste are biological oxygen demand, total suspended solids, coliform bacteria, and residual chlorine. Sanitary waste will be treated to reduce coliform bacteria and suspended solids to levels to set by regulations. Residual waste in sanitary discharges could cause increases in total suspended solids, turbidity, biological oxygen demand, and chlorine surrounding the immediate area of discharge.

Domestic waste (or gray water) refers to materials discharged from sinks, showers, laundries, and galleys which can kitchen solids, detergents, cleansers, oil, and grease. Domestic waste also refers to solid materials such as paper and cardboard, which must be disposed according to regulations.

Water discharged from bilges would be treated in an oily water separator before discharge to the sea, minimizing the concentration of potential pollutants. Ballast water is water pumped in or out to of a vessel to maintain vessel stability. Ballast water discharges during this proposed survey may contain contaminants such as rust-inhibitors and sealants. A vessel entering U.S. waters is required to complete one or more mid-ocean ballast water exchanges to help prevent the unintentional introduction of non-native species.

The effects of the discharges from the Noticed Activity on water quality would be minor and temporary.

3.3.2.3. Cumulative Effects

There are several factors that are currently influencing the Chukchi Sea environment such as the presence and transits of cargo barges, cruise ships, research vessels and ongoing oil and gas activities. These activities could cause vessel fuel spills, petroleum spills, nonpoint runoff to the sea, and aerosol deposition on to the water surface.

Ongoing climate change effects include warming sea surface temperatures, reduction in sea ice extent and thickness, and increased acidity. These ongoing effects contribute to cumulative effects on water quality.

The effect of the proposed survey, when combined with past, present and reasonably foreseeable future activities, would remain minor for water quality throughout the region.

3.3.3. Lower Trophic Levels

3.3.3.1. Affected Environment

The physical environment of the Chukchi Sea is commonly thought to hold the highest benthic faunal biomass of all the continental shelves surrounding the Arctic Ocean (Grebemeier, et al., 2006). The primary contributions leading to the presence of such diversity and abundance of animal life on this shelf are the richness of primary production in the pelagic and surface waters of the region (Hopcroft,

Kosobovka, and Pinchuk, 2010), and the plankton from annual blooms and early season ice melt that is not consumed by secondary consumers and drifts to the benthic surface in the form of marine snow (Grebmeier, 1989). Complete descriptions of these communities were provided in the Chukchi Sea Sale 193 Final SEIS (USDOI, BOEMRE, 2011) and the Programmatic Environmental Assessment of Seismic Activities for the Arctic Outer Shelf (USDOI, MMS, 2006). These descriptions are incorporated here by reference.

Common lower trophic organisms of the pelagic environment that would most likely be affected by the Noticed Activity are the members of the plankton blooms that normally occur in the open water season (July-August), in particular the zooplankton masses that feed on the phytoplankton. These include larval stages of many crustaceans and polychaetes, larval fish (also known as ichthyoplankton), euphausiids, copepods, amphipods, larvaceans, pteropods, and many other organisms that depend on the planktonic masses for some or all of their life cycles (Hopcroft, Questel, and Clarke-Hopcroft, 2008 and 2009). Pelagic organisms, those that primarily inhabit the water column, include squid, larvaceans, pteropods, jelly fish, ctenophores, and numerous larvae of invertebrates and fish (Lane, et al., 2008; Hopcroft, Kosobovka, and Pinchuk, 2010).

3.3.3.2. Direct and Indirect Effects

Direct and indirect effects of the Noticed Activity on these lower trophic communities include potential disruption of the life cycle of trophic organisms from seismic and sonar ensonification of the water column, effluents and discharges from vessel activities, and the movement and actions of vessels.

Seismic and sonar energy, at the levels of energy released by the deep penetration and medium penetration profilers, are not known to cause damage to the internal organs of most pelagic organisms discussed above. The most well documented exception to this is the stranding of giant squid (*Architeuthis dux*) off the coast of Spain in 2001 and 2003, which coincided with vessels conducting seismic surveys using air guns. Investigations found pathological damage to the statocyst organs (a sensory organ comparable to the mammalian cochlea) of the beached squid (André et al., 2011). In response to these occurrences, experimental work was conducted by André et al. (2011) using four cephalopod species. This study indicated changes in the statocyst organ as a result of low-energy, high-frequency sound. However, the sonic energy released by those seismic energy sources were a higher level of intensity than those proposed for use in the Noticed Activities. Energy utilized by the sonar components of the Noticed Activity are not known to cause damage to invertebrate animals. Therefore, all possible effects of seismic and sonar activities are expected to be negligible for lower trophic populations.

Effluents and discharges from vessel activities are also expected to be negligible and temporary due to regulations in place through EPA and MARPOL regulations. Movement and actions of vessels will have negligible effects on invertebrate populations when the depth and presence of the few listed vessels to be utilized are considered.

3.3.3.1. Cumulative Effects

Cumulative effects include the potential effects of energy emitted by air-gun arrays during survey operations. The cumulative effects also include those ongoing, planned, or reasonably foreseeable activities discussed in Appendix B, Cumulative Effects. The incremental contribution of the Noticed Activity to overall cumulative effects on lower trophic populations is expected to result in a negligible level of effect.

3.3.4. Fish

3.3.4.1. Affected Environment

The Alaskan U.S. Chukchi Sea supports at least 98 fish species. Twenty-three families have been documented to occur (Mecklenburg, Mecklenburg, and Thorsteinson, 2002). These families include lampreys, sleeper sharks, dogfish sharks, herrings, smelts, whitefishes, trouts and salmons, lanternfishes, cods, sticklebacks, greenlings, sculpins, sailfin sculpins, fathead sculpins, poachers, lumpsuckers, snailfishes, eelpouts, pricklebacks, gunnels, wolffishes, sand lances, and righteye flounders (USDOI, MMS, 2007: Section III.B.2.a – III.B.2.b). Several important surveys have been conducted in the Chukchi Sea over decades that contribute to the knowledge of the fish species that occur. A discussion of these fish surveys is presented in the Lease Sale 193 and Seismic Surveying EIS (USDOI, MMS, 2007: Section III.B.2.a.) and is summarized and incorporated here by reference.

The most commonly occurring marine fish species that occur in the northern Chukchi Sea are presented in Table 1.

Table 1. Marine fish (common and taxonomic names) that commonly occur in the northern Chukchi Sea in the region of the noticed activities.

Common Name	Taxonomic Name
Arctic cod	<i>Boreogadus saida</i>
Saffron cod	<i>Eleginus gracilis</i>
Bering flounder	<i>Hippoglossoides robustus</i>
Yellowfin sole	<i>Limanda aspera</i>
Sculpin species	Family Cottidae
Sailfin sculpin species	Family Hemitripterae
Pacific herring	<i>Clupea pallasii</i>
Sand lance	<i>Ammodytes hexapterus</i>
Capelin	<i>Mallotus villosus</i>
Eelpout species	Family Zoarcidae
Alaska plaice	<i>Pleuronectes quadrituberculatus</i>
Starry flounder	<i>Platichthys stellatus</i>
Snailfish	Family Liparidae
Alligator fish	Family Gasterosteidae
Prickleback species	Family Stichaeidae

Marine waters of the northern Chukchi Sea provide varied habitats for Arctic fishes to exploit. These habitats include neritic waters and substrates (occurring landward of the continental shelf break, as delimited by the 200 m isobath) and oceanic waters and substrates (occurring seaward of the continental shelf break [>200 m isobath]). The diverse fish species of the U.S. Chukchi Sea use this range of waters and substrates for feeding, breeding, spawning, and growing to maturity (USDOI, MMS, 2007: Section III.B.2.a – III.B.2.b).

Anadromous fish (that spend part of their life at sea and return to spawn in rivers and streams along the Arctic coast) include five species of Pacific salmon (*Oncorhynchus sp.*) (Table 2). Of the five species, pink salmon (*O. gorbuscha*) and chum salmon (*O. keta*) occur most commonly in the northern Chukchi Sea. There are indications of small runs of chinook salmon in the Kugrua River, through Elson Lagoon (Fechhelm and Griffiths, 2001, citing George, pers. commun.), and strays have been captured in the Kuk River, near Wainwright (Craig and Halderson, 1986). Other anadromous fish in the northern Chukchi Sea include rainbow smelt, Dolly Varden-sea-run, and arctic lamprey which spend some of their life in the marine environment and return to freshwater to spawn (Table 2).

Several fish species such as capelin, sand lance, saffron cod and some sculpin species are not considered anadromous or coastwise migratory fish but they regularly move from offshore to nearshore for spawning and rearing in nearshore habitats.

Table 2. Anadromous fish occurring in offshore marine environment in the northern Chukchi Sea in the region of noticed activities.

Common Name	Taxonomic Name
Pink salmon	<i>Oncorhynchus gorbuscha</i>
Chum salmon	<i>Oncorhynchus keta</i>
Coho salmon	<i>Oncorhynchus kitsutch</i>
Chinook salmon	<i>Oncorhynchus tshawtscha</i>
Rainbow smelt	<i>Osmerus mordax</i>
Dolly varden (sea-run)	<i>Salvelinus malma</i>
Arctic lamprey	<i>Lamptera camschatica</i>

3.3.4.2. Direct and Indirect Effects

The most likely impacts to marine fish from the Noticed Activities would be behavioral disruptions from geophysical survey sound, vessel traffic, and permitted discharges. Behavioral changes to marine fish and invertebrates from seismic-survey activity have been described in several studies (e.g., Dalen and Knusten, 1987; McCauley et al., 2000; McCauley, Fewtrell, and Popper, 2003; Pearson, Skalski, and Malme, 1992), including balance problems (but recovery within minutes); disoriented swimming behavior; increased swimming speed; tightening schools; displacement; interruption of important biological behaviors (e.g., feeding, mating); shifts in the vertical distribution (either up or down); and occurrence of alarm and startle responses (generally around 180 dB re 1 μ Pa and above). Behavioral impacts are most likely to occur in the 160- to 200-dB range (Turnpenney and Nedwell, 1994).

The responses of fish to the survey activities are expected to differ among fish species and likely to be short-term in nature. Although repeated short-term disturbances can result in long-term impacts, the noticed seismic activity would be limited to the area defined in the northern Chukchi Sea and to the timeframe specified in the noticed plan.

The effects on fish would most likely occur in close proximity to the sound source, the site of waste discharge, and the vessel tracklines. The effects of the Noticed Activities on fish would be negligible.

3.3.4.3. Cumulative Effects

There are several factors that are currently influencing the Chukchi Sea environment such as the presence and transits of cargo barges, cruise ships, research vessels and ongoing oil and gas activities. These activities could cause vessel fuel spills, petroleum spills, nonpoint runoff to the sea, and aerosol deposition on to the water surface.

Ongoing climate change effects include warming sea surface temperatures, reduction in sea ice extent and thickness, and increased acidity. These ongoing effects contribute to cumulative effects on fish and fish habitat in the Chukchi Sea.

The noticed geophysical activities (from mid-July to mid-October, 2013) would contribute a negligible effect to the current overall cumulative effects listed in Appendix B on fish and fish habitat.

3.3.5. Marine and Coastal Birds

3.3.5.1. Affected Environment

Most marine birds that occur in the Chukchi Sea are there during the open-water season. Arrival times to coastal breeding areas usually coincide with the formation of leads during spring migration to coastal breeding areas. Spring migration for most species takes place between late March and late May.

Some birds that breed on the North Slope migrate to or through the Noticed Activity area (Figure 1) twice each year. Some marine and coastal birds may breed outside the project area, but spend time in the Chukchi Sea after breeding or during their non-breeding seasons. Departure times from the Chukchi Sea for the fall and winter vary between species and often by sex within the same species, but most marine and coastal birds will have moved out of the Chukchi before the formation of sea ice.

Full descriptions of the most important marine and coastal bird species in the Chukchi Sea were provided in the Lease Sale 193 and Seismic Surveying EIS (MMS, 2007), and the Lease Sale 193 Final SEIS (USDOI, BOEMRE, 2011). These descriptions are summarized and updated with site-specific information below. Recent information, especially from the Klondike and Burger prospects (over 50 miles offshore in the Chukchi Sea), is consistent with previous descriptions.

Descriptions of Species or Species Groups

Marine and coastal birds potentially affected by this action can be grouped according to certain aspects of their life-history or status: ESA-listed birds, loons and waterfowl, and seabirds (Table 3).

The timing and specific location of the Noticed Activity influence which birds could be affected.

Birds listed as threatened or candidate (four species) or abundant in the three Noticed Activity areas (five species) have the greatest potential for adverse effects and are described further. The effects of the Noticed Activity were evaluated for these nine species.

Table 3. Marine and coastal birds most likely to be affected by the Noticed Activities.

Species	Threatened or candidate species	Abundant in offshore Noticed Activity area	Carried forward under effects analysis
<i>ESA-Listed Species</i>			
Spectacled Eider	Yes		Yes
Steller's Eider	Yes		Yes
Kittlitz's Murrelet	Yes		Yes
Yellow-billed Loon	Yes		Yes
<i>Loons and Waterfowl</i>			
Long-tailed Duck		Yes	Yes
Common Eider		Yes	Yes
King Eider		Yes	Yes
<i>Seabirds</i>			
Northern Fulmar		Yes	Yes
Short-tailed Shearwater		Yes	Yes

Source: USDOI MMS (2007), USDOI BOEMRE (2011).

Note: An Empty cell indicates Not Applicable.

ESA-listed Birds

The distribution, abundance, and legal status of birds designated as threatened or listed as candidate species under the ESA are most recently described in the ESA Section 7 Biological Opinion (USDOJ, USFWS, 2012). Those descriptions are summarized and incorporated by reference below. These include the Steller's eider (*Polysticta stelleri*; threatened), the spectacled eider (*Somateria fisheri*; threatened), the Kittlitz's murrelet (*Brachyramphus brevirostris*; candidate species), and the yellow-billed loon (*Gavia adamsii*; candidate species) and are collectively referred to here as ESA-listed birds.

Spectacled Eider. The North Slope spectacled eider population seems to be stable, at least since the initiation of aerial surveys of the Arctic Coastal Plain (ACP) in 1992 (Larned, Stehn, and Platte, 2009). Spectacled eiders breed in low densities across the Alaskan ACP east to about the Shaviovik River. Males leave the breeding grounds along the ACP for the ocean around mid-to-late June at the onset of incubation by female eiders. Males are followed by females whose nests fail, and finally by successful breeding females and young birds in August and September. Spectacled eiders migrate west along the Alaska coast as far as 40 km offshore. Most spectacled eiders molt in the Ledyard Bay Critical Habitat Unit and will have migrated from the Beaufort Sea by mid-October. Spectacled eiders occur less frequently offshore in the Chukchi Sea; however, a small number of adult males and hatch-year birds may migrate to molting areas in Russia, likely taking a western route from Barrow (Sexson, 2013; Gall and Day, 2012).

Steller's Eider. A small number of Steller's eiders breed on the ACP of Alaska, most conspicuously near Barrow. Steller's eiders are rare as the breeding season progresses due to molt migration, failed breeding, etc. As with the more common spectacled eider, these birds move to nearshore coastal waters after their breeding season. Few if any Steller's eiders would concentrate in southern areas of the Chukchi Sea during or after the open-water season, but low numbers would be passing through the area starting as early as May and as late as November.

Yellow-billed Loon. The yellow-billed loon is relatively rare in the U.S. Arctic region (North, 1994). Dau and Bollinger (2009) reported an average of fewer than 50 yellow-billed loons during late-June surveys of the coast and barrier islands between Omalik Lagoon (Chukchi Sea) and the Canadian Border (2005-2009). Of the approximately 3,300 yellow-billed loons present on the breeding grounds on the North Slope, primarily between the Meade and Colville rivers in the National Petroleum Reserve-Alaska (NPR-A), it is likely that there are fewer than 1,000 nesting pairs because some of the 3,300 are nonbreeders. Additionally, there are approximately 1,500 yellow-billed loons (presumably juvenile nonbreeders) that remain in nearshore marine waters or in large rivers during the breeding season. In total, there are fewer than 5,000 yellow-billed loons on the Arctic coast breeding grounds and near shore marine habitat (Earnst et al., 2005). There may be approximately 1,500 yellow-billed loons, presumably non-breeding adults and immatures, in near shore marine waters or in large rivers during the breeding season.

Yellow-billed loons typically nest on low islands or narrow peninsulas on the edges of large, deep, tundra lakes. Breeding yellow-billed loons typically remain on their lakes until young are fledged.

Most yellow-billed loons from the ACP have moved into nearshore coastal waters by September. In addition, approximately 8,000 yellow-billed loons from the Canadian Arctic travel across the Chukchi Sea during spring and fall migration between Canada and wintering grounds in eastern Asia (Schmutz et al., 2010). Most loons stay very close to shore during fall migration until they reach the Lisburne Peninsula, where they head farther out to sea towards the Bering Strait (Rizzolo and Schmutz, 2010).

Yellow-billed loons were observed at the Burger Prospect during seabird surveys in 2008 and 2009 (Gall and Day, 2012). Most sightings of yellow-billed loons represented low numbers of birds during the survey period; however, 24 were observed during the early fall period in 2009. Eight yellow-

billed loons were reported by Gall and Day (2012) near Hanna Shoal in 2011, about 100 miles from the coastal mainland. No yellow-billed loons were observed during seabird surveys in the Chukchi Sea in late August and early September 2011 (Kuletz, 2011) or in 2012 (Labunski and Kuletz, 2012; Reedy and Kuletz, 2012). Low numbers, patchy distributions, and specific habitat requirements may make yellow-billed loons more susceptible to environmental perturbations such as disturbance, habitat alterations, and oil spills than species that are more abundant, widely distributed, and able to exploit a greater diversity of habitats. Yellow-billed loon numbers are considered to be declining (*Federal Register* 74:56, March 25, 2009).

Kittlitz's Murrelet. This species may nest as far north as Cape Beaufort. Breeding along the Arctic Coastal Plain is unlikely due to lack of suitable habitat. Kittlitz's murrelets have been observed on an infrequent basis in the Chukchi Sea as far north and east as Point Barrow, but there appears to be a great deal of annual variation in their occurrence. Small numbers of Kittlitz's murrelets were recorded during late fall seabird surveys in the Klondike and Burger Prospect areas in 2009 and 2010, but none were observed in 2008 (Gall and Day, 2012). Murrelet foraging areas occur in the Chukchi Sea (Day et al., 2011). Murrelet foraging areas may occur offshore near Barrow. Recent telemetry studies have documented that many Kittlitz's in the Arctic are from other regions of Alaska, most notably the Gulf of Alaska and Aleutian Islands (Madison et al., 2011). Kittlitz's murrelet numbers in these regions are declining (Day et al., 2011).

Other Birds

Loons and Waterfowl. The Pacific loon (*Gavia pacifica*), red-throated loon (*G. stellata*), Pacific brant (*Branta bernicla nigricans*), lesser snow goose (*Chen caerulescens caerulescens*), greater white-fronted goose (*Anser albifrons frontalis*), and tundra swan (*Cygnus columbianus*) occur in nearshore coastal waters of the Chukchi Sea (USDOI, MMS, 2007b; USDOI, BOEMRE, 2011). Waterfowl species that are more abundant and occur in more offshore areas of the Chukchi Sea include the long-tailed duck (*Clangula hyemalis*), the common eider (*Somateria mollissima*), and the king eider (*Somateria spectabilis*) and are described below.

Long-Tailed Duck. The long-tailed duck population has decreased considerably since 1989, but it remains a common species in the Chukchi Sea during the open-water period (Mallek, Platte, and Stehn, 2007).

In late June and early July, most male and nonbreeding female long-tailed ducks migrate to coastal molting areas where they are flightless for a 3- to 4-week period. Breeding females molt on freshwater lakes during the last phases of duckling development before departing the North Slope in fall. The molt is an energetically costly time, and long-tailed ducks have abundant food resources in the shallow water lagoons (Flint et al., 2003). Many long-tailed ducks molt in Kasegaluk Lagoon and Peard Bay on the Chukchi Sea coast. Molting long-tailed ducks tend to stay in or near the lagoons, feeding heavily in passes between barrier islands and the open ocean (Johnson, Frost, and Lowry, 1992; Johnson, Wiggins, and Wainwright, 1992; Kinney, 1985).

The long-tailed duck is a common species in the Chukchi Sea after the first week of September until late October. While most long-tailed ducks migrate within 45 km (28 mi) of shore, infrequent observations of long-tailed ducks in pelagic waters occur in late September (Divoky, 1987). Aerial surveys along coastal habitats of the entire ACP typically observe fewer than 7,500 long-tailed ducks, with about two-thirds of these associated with mainland habitats (Dau and Bollinger, 2009). Fewer than 70 long-tailed ducks were observed during any survey period at the Burger Prospect during seabird surveys (2008-2010) and no long-tailed ducks were observed during most survey periods (Gall and Day, 2012).

Common Eider. Common eiders nest on barrier islands or spits along the coast, more along the Beaufort Sea than the Chukchi Sea. In 2007, total birds and indicated breeding pairs surveyed along

the Beaufort Sea coast were down 37.6% and 44.0%, respectively, from 2006 counts of 3,102 birds and 1,207 pairs. Total birds and indicated breeding pairs in 2007 were down 30.0 and 27.8%, respectively, from the 1999-2006 averages of 2,766+885 (1 standard deviation, range 1,353- 4,449) birds and 937+264 (1 standard deviation, range 572-1,340) pairs (Dau and Larned, 2007). Common eider numbers appear to be declining in the region.

Beginning in late June, postbreeding male common eiders begin arriving in molting areas in the Chukchi Sea; by late August, most common eiders in the Chukchi Sea are molting males. When traveling along the northwest coast of Alaska, these eiders tend to stay along the 20-m isobath, approximately 48 km (29 mi) from shore. Most breeding female common eiders and hatch-year birds begin to migrate to molt locations in late August and September. Common molt areas in the Chukchi Sea are near Point Lay, Icy Cape, and Cape Lisburne. Kasegaluk Lagoon and Peard Bay also are important locations for molting and during migration. After the molt is completed, some common eiders move offshore into pelagic waters, but most eiders remain close to shore. Less than 10 common eiders were observed at the Burger, Klondike, or Statoil prospects during seabird surveys in 2008, 2009, and 2010 (Gall and Day, 2012). A small number of common eiders were reported by Gall and Day (2012) in the Hanna Shoal survey area in 2011.

King Eider. Most king eiders migrate through the Chukchi Sea by the middle of May, dependent upon the location and timing of offshore leads (Barry, 1986). Most king eiders nesting on the North Slope between Icy Cape and the western boundary of ANWR nested in three general areas: between the Colville River and Prudhoe Bay, southeast of Teshekpuk Lake and a large area near Atkasuk (Larned, Stehn, and Platte, 2006). Dau and Larned (2005, 2006, 2007, 2008) surveyed the Chukchi Sea and Beaufort Sea coastlines and found 810, 3048, 1621, and 2227 king eiders in 2005, 2006, 2007, and 2008, respectively.

Many post-breeding male king eiders move to staging areas along the Chukchi Sea in mid- to late July. Ledyard Bay and Peard Bay appear to be particularly important to molting and migrating king eiders (Oppel, Dickson, and Powell, 2009). Hundreds of thousands of king eiders move through the Chukchi Sea during their migration from breeding grounds in eastern Canada. No more than two king eiders were observed during any seabird survey period in 2008 or 2010 at the Klondike and Burger prospects and no king eiders were observed in 2009 (Gall and Day, 2012). Eight king eiders were reported by Gall and Day (2012) near Hanna Shoal in 2011, about 100 miles from the coastal mainland.

The king eider population in the region appeared to remain stable between 1953 and 1976 but declined by 56% between 1976 and 1996 (Suydam et al., 2000).

Seabirds

The common murre (*Uria aalge*), thick-billed murre (*U. lomvia*), tufted puffin (*Fratercula cirrhata*), horned puffin (*F. corniculata*), black-legged kittiwake (*Rissa tridactyla*), black guillemot (*Cepphus grylle*), Ross' gull (*Rhodostethia rosea*), ivory gull (*Pagophila eburnea*), Arctic tern (*Sterna paradisaea*), pomarine jaeger (*S. pomarinus*), parasitic jaeger (*S. parasiticus*), long-tailed jaeger (*S. longicaudus*), and glaucous gull (*Larus hyperboreus*) occur in the Chukchi Sea (USDOI MMS (2007); USDOI, BOEMRE (2011)). Seabird species that are more abundant and occur in offshore areas include the northern fulmar (*Fulmarus glacialis*) and the short-tailed shearwater (*Puffinus tenuirostris*) and are described below.

Northern Fulmar. Fulmars do not breed in the Arctic region, and those observed during the summer are nonbreeders or failed breeders from southern areas. Fulmars are most numerous from late August to mid-September. Divoky (1987) estimated 45,000 northern fulmars in pelagic waters of the southern Chukchi Sea during late August to mid-September. Flocks totaling in the low hundreds were

observed during the late summer and early fall around the Klondike and Burger prospects during seabird surveys in 2008, 2009, and 2010 (Gall and Day, 2012).

Short-Tailed Shearwater. Shearwaters do not breed in the Arctic region. These birds breed in the Southern Hemisphere. At northern latitudes, short-tailed shearwaters likely forage at highly productive patches of euphausiids and amphipods. Divoky (1987) reported short-tailed shearwaters north of Barrow and into Arctic Canada, depending on the presence of sea ice. In certain years, an estimated 100,000 short-tailed shearwaters passed Point Barrow in one day in mid-September (Divoky, 1987).

Gall and Day (2012) suggested that the shearwaters can rapidly respond to changes in oceanic conditions and exploit food resources when and where they are available. Kuletz (2011) reported over 4,000 shearwaters during a seabird survey in the Chukchi Sea in late August – early September 2011 (the most abundant species reported), with many flocks numbering between 150-300 birds. These observations were consistent with those of Bankert (2012). Similarly, flocks totaling in the low hundreds were observed during the early fall around the Klondike, Burger, and Statoil prospects during seabird surveys in 2008-2011 (Gall and Day, 2012); however, during the early fall period in 2009, almost 12,000 short-tailed shearwaters were observed near the Klondike Prospect. Over 1,800 short-tailed shearwaters were reported by Gall and Day (2012) near Hanna Shoal in 2011, about 100 miles from the coastal mainland.

3.3.5.2. Direct and Indirect Effects

Potential adverse effects of the Noticed Activity on coastal and marine birds are summarized according to:

- Disturbance from the physical presence of vessels.
- Disturbance from noise by vessels or seismic airguns.
- Birds encountering/striking vessels.

Vessels could disturb birds in their path. There is an energetic cost to repeatedly moving away from vessel disturbances as well as a cost in terms of lost foraging opportunities or displacement to an area of lower prey availability. Seismic survey activity is expected to have only temporary and localized disturbance effects on relatively small numbers of certain marine bird species that are distributed in low density over the Noticed Activity areas. Any displacement to these birds is expected to be temporary.

The Noticed Activities includes the limited deployment/retrieval of three passive acoustic monitoring devices in the Ledyard Bay Critical Habitat Unit. The passive acoustic monitoring array is an ongoing requirement of the NMFS IHA. Operational procedures will reduce vessel time/travel in this area to the minimum amount necessary and are expected to avoid interactions with listed eiders. These operational procedures have been effective in avoiding disturbance impacts to listed eiders. Due to operational procedures to avoid disturbing listed eiders during these two entries into the LBCHU, this aspect of the Noticed Activity would have a negligible, if any, effect on listed eiders.

During the course of normal feeding or escape behavior, some birds could conceivably be near enough to an airgun to be injured by a pulse. The reactions of birds to airgun noise suggest that a bird would have to be very close to the airgun to receive a pulse strong enough to cause injury, if that were possible at all. Injury to birds in offshore waters from the presence of vessels or noise from airguns and vessels is expected to result in a negligible level of effect because birds are most likely to move away from slow-moving seismic vessels well in advance of the towed seismic-airgun array.

Seabirds, attracted to lights and vessels in nearshore waters, could collide with a vessel and be injured or killed. Marine and coastal birds could also be disoriented by storms or collide with vessels during inclement weather (e.g., fog, rain) or darkness. Vessels operating in marine environments often

encounter passerines and shorebirds species when the birds are migrating. In 2012, Shell Gulf of Mexico, Inc. and Shell Offshore, Inc. (collectively referred to as Shell) conducted an exploration drilling program in the Chukchi and Beaufort seas. Shell reported that at least 131 birds were observed on their drilling units and support vessels, Eighty-two (82, 63%) of the birds reported were found dead or died onboard the vessel. Sixty-eight of these reports involved support vessels like the *Fennica*. Some birds appeared to seek refuge on a vessel in inclement weather and used it to rest and continued their migration. In other cases, exhausted birds alighted on the vessels and did not survive. The injuries and mortalities, however, strongly indicated birds collided with the vessel superstructures and died or later succumbed to injuries. The *Fennica* was one of the vessels used by Shell during the 2012 season and was involved in 28 bird collision reports. Six of these involved passerines, but the remaining 22 strike reports involved 10 long-tailed ducks and 12 king eiders. The *Fennica* accounted for 59% of all seaducks reported on Shell vessels during 2012.

Using these preliminary data, a low level of bird/vessel encounters during the 2013 open water season would be expected, of which not all would be expected to be fatal. Of these, shearwaters, auklets and passerines would be the most frequent species groups reported. This low number of encounters affecting a broad diversity of species over a season would not be expected to result in a population-level effect. The low level of bird mortality from vessel collisions for most species would be considered a minor level of effect.

While no listed eiders, yellow-billed loons, or Kittlitz's murrelets were documented by Shell to interact with their vessels in 2012, king and common eiders, a grebe, and several auklet species were reported. These reports suggest that listed spectacled or Steller's eiders, loons, or murrelets could be involved in future collisions. Shell proposes to work primarily in areas farther from shore where bird densities are typically lower. A yellow-billed loon or a Kittlitz's murrelet strike would be considered a significant effect because these species populations are declining and the loss of one yellow-billed loon or Kittlitz's murrelet would not be recovered in a generation. However, such an event is unlikely and not reasonably expected to occur.

Overall, the Noticed Activities are expected to have a minor level of effect on marine and coastal birds.

3.3.5.3. Cumulative Effects

Appendix B, Cumulative Effects Scenario, identifies other activities that could overlap in space and time with the Noticed Activities. The direct and indirect effects of the Noticed Activities would result in a negligible level of effect because there are few activities that would occur in space and time with the Noticed Activities in the Action area and the effects of the Noticed Activities would not persist from one year to the next. The incremental contribution of the Noticed Activities to overall effects on marine and coastal birds is expected to result in a negligible level of cumulative effect.

3.3.6. Marine Mammals

3.3.6.1. Affected Environment

Eight cetacean species (bowhead whale, fin whale, humpback whale, gray whale, minke whale, beluga whale, killer whale, and harbor porpoise) could occur in the Chukchi Sea during the open-water period. Five pinniped species (Pacific walrus and four species of ice seals: ringed, bearded, spotted, and ribbon seals) could be encountered in the Chukchi Sea. Polar bears may be encountered offshore. For more detailed life history, stock, population size, and other information for these species, see the Lease Sale 193 EIS (USDOI, MMS, 2007). Most species will occur in low densities and encounters would be most common within 100 km of shore where waters are less than 200 m deep or along the shelf break.

Very low numbers of ribbon seals, harbor porpoises, fin whales, humpback whales, minke whales, and killer whales have been observed in the Chukchi Sea, but these six species will not be discussed further in this analysis since an encounter with them is not reasonably foreseeable.

Bowhead whales, gray whales, beluga whales, walruses, bearded seals, ringed seals, spotted seals, and polar bears are more abundant species in the Chukchi Sea, and are likely to be encountered during the Noticed Activities. These eight species are described below and are carried forward in the analysis (Section 3.3.6.2.).

Bowhead Whale. The Western Arctic bowhead whale stock are seasonal visitors to the Chukchi Sea during the open water season. They are estimated to number around 10,314 individuals, with an estimated 3.2% annual rate of increase (Allen and Angliss 2013). Most bowheads reside in the eastern Beaufort Sea throughout the summer (Moore, Clarke, and Ljungblad, 1989; Moore and Reeves, 1993; Moore et al., 2000; Moore et al., 2002), though recent tagging information suggests some bowhead whales remain in the Chukchi Sea later in the fall than previously believed, and overwinter in the Chukchi Sea (Quakenbush et al., 2010). In autumn, bowheads leave the Beaufort Sea, traveling across the Chukchi Sea to Chukotka Peninsula waters and Bering Sea wintering areas from mid-September thru November (Moore et al., 1995). The Noticed Activities are positioned across the fall migration route of bowheads leaving the Beaufort Sea.

Bowhead whales in the Noticed Activities area are listed as endangered under the ESA.

Gray Whale. An estimated 18,017 gray whales compromise the Eastern Pacific Stock. They feed on benthic and pelagic invertebrates and small fishes, and are most common in coastal and shoal waters with little sea ice, particularly in larger bays and near Barrow Canyon (Allen and Angliss 2012). Gray whales are seasonal migrants to the Bering and Chukchi Seas, arriving in late spring after bowheads have passed through and most of the ice has receded.

Beluga Whale. The Beaufort Sea (BSS) and the Eastern Chukchi Sea (ECS) stocks of beluga whales occur in the northeastern Chukchi Sea. These stocks total over 36,000 individuals and population trends are unknown or presumed declining (Allen and Angliss 2012). Both stocks overwinter in the Bering Sea and summer in the Beaufort Sea and Chukchi Sea, using spring lead systems to migrate around western and northern Alaska in April and May (Richard, Martin, and Orr, 2001; Allen and Angliss, 2012). Moore (2000) and Moore, DeMaster, and Dayton (2000) suggest belugas select deeper water near the continental shelf break to feed on fish, independent of ice cover. Consequently, they would be likely to be encountered in the northern portions of the Noticed Activities area.

Bearded Seal. Bearded seals in the Chukchi Sea are considered to be part of the Beringian Distinct Population Segment (BDPS) of the circumpolar bearded seal population (Allen and Angliss 2012). Allen and Angliss (2012) offered a rough population estimate of 155,000 for the BDPS of bearded seals based on the analyses in Cameron et al. (2010) and recommended a theoretical maximum annual net productivity rate of 12% for this population. Most BDPS bearded seals summer in the Chukchi Sea, feeding mostly on benthic invertebrates and some fishes (Burns, 1970; Stirling, Kingsley and Calvert, 1982; Stirling, 1997). Physiological limitations on their forage depth restricts bearded seals to continental shelf waters no deeper than 200 meters. They are commonly observed during oil and gas exploration in the Chukchi Sea during the open water season and are highly likely to be encountered. NMFS (Allen and Angliss 2012) does not list the BDPS of bearded seals as depleted, strategic, or decreasing.

In 2012 the BDPS was listed as threatened under the ESA because of the anticipated effects of climate change on their habitat (77 *FR* 31068, 28 December, 2012).

Ringed Seal. The Arctic subspecies of ringed seal is the most abundant seal species in the Chukchi. Conservative population estimates exceed 1,000,000, with an estimated annual maximum theoretical net productivity rate of 12%. Arctic ringed seals are dispersed in the open-water season, foraging on

fishes and pelagic invertebrates. During the open water season, they are the most commonly encountered seal and marine mammal species. NMFS (Allen and Angliss 2012) does not list the Alaskan stock of this species as depleted, decreasing, or strategic.

The Arctic ringed seal is listed as threatened under the ESA with no designated critical habitat or a recovery plan (Kelly et al. 2010; Allen and Angliss 2013; 77 FR 31066, 28 December, 2012).

Spotted Seal. The Alaskan stock of spotted seals inhabits the Bering Sea and Chukchi Sea. Recent estimates place Spotted seal numbers at 141,479 individuals in the eastern and central Bering Sea during winter, and NMFS assumes the population's theoretical net productivity rate is about 12% (Allen and Angliss 2012). Spotted seal occurrences are more frequent in the southern Chukchi Sea than the northern Chukchi, with large numbers hauling out in Kasegaluk Lagoon and other coastal protected areas in Peard Bay, and points south. Spotted seals periodically rest on sea ice or at coastal haulouts when not foraging on a variety of pelagic fish and invertebrate species. Spotted seals are abundant in the Chukchi Sea and could be encountered in the Noticed Activities area.

Pacific Walrus. Pacific walruses are typically associated with the moving pack ice year-round. Although capable of diving to depths beyond this, Pacific Walruses are usually found in waters of 100 meters or less, possibly because of higher productivity of benthic invertebrates in the shallower water (Fay 1982). They winter in the Bering Sea and the majority of the population is found during the summer and early fall throughout the Chukchi Sea. Pacific walrus are uncommon in the Chukchi Sea during late fall and winter. Recent reports indicate that climate change has caused walrus to move to terrestrial haulouts in the Chukchi Sea in summer when the sea ice retreats northward. This increases the likelihood of injury and death during stampedes at crowded haulouts, particularly for calves (Fischbach et al, 2009).

On February 10, 2011, the USFWS completed a status review of the Pacific walrus and determined that although listing the species was warranted, the listing was precluded by other higher priority actions. The Pacific walrus is now designated a candidate species under the ESA (76 FR 7634).

Polar Bear. Polar bears occur on the pack and shorefast ice, along the coast, and on barrier islands. There are two polar bear stocks recognized in Alaska: the southern Beaufort Sea stock (SBS) and the Chukchi/Bering Seas stocks (CBS), though there is considerable overlap between the two. Polar bear habitat use and distribution may reflect more than prey availability; it also may reflect time allocated for hunting prey and the use of retreat habitats (Durner et al 2004). Modeling of polar bear ice habitat selection show that shallow-water areas where different ice types intersect are preferred (Durner et al, 2004; Durner et al, 2009).

The polar bear is listed as threatened throughout their range under the ESA. The USFWS established critical habitat for the polar bear on December 7, 2010 (74 FR 76058). On January 11, 2013, the U.S. District Court in Alaska issued an order setting aside the USFWS Critical Habitat designation for polar bears as the result of a lawsuit filed by the State of Alaska, the Alaska oil and Gas Association and the Arctic North Slope Regional Corporation (Case 3:11-cv-00025-RRB).

3.3.6.2. Direct and Indirect Effects

The potential effects from geophysical and geologic surveys on marine mammals in the Chukchi Sea have been evaluated by the Programmatic Environmental Assessment (USDOI, MMS 2006), the Lease Sale 193 EIS (USDOI, MMS 2007), the National Marine Fisheries Service review of the Incidental Harassment Authorization, and the Programmatic Biological Opinion (issued to BOEM, dated April 2, 2013; NMFS 2013) and are evaluated by Shell in their Ancillary Activity Notice. These analyses are incorporated by reference.

Potential effects of the noticed seismic-survey activities on marine mammals are summarized in categories of:

- Disturbance from the physical presence of vessels.
- Disturbance from vessel and seismic airgun noise.
- Vessels striking marine mammals.

No refueling at sea is planned. The survey vessel to be used for the geophysical surveys will likely be a long range vessel capable of storing fuel in sufficient quantities for the season. Any refueling required by the vessel to be used would be done in Nome or Dutch Harbor and a fuel spill is not anticipated to affect marine mammals in the Noticed Activities area.

Physical Presence of Vessels. Generally, marine mammals resting on ice, especially walruses and ice seals, would enter the water if closely approached by a vessel. PSOs and vessel crew would be on the constant look-out for marine mammals on ice or in the water and would avoid disturbing them with close approaches. Careful monitoring and avoidance procedures will minimize impacts to marine mammals from vessel disturbance.

Vessel and Airgun Noise. Vessels have a transitory and short-term presence in any specific location. Marine mammals typically avoid vessels operating in open water, including vessels engaged in conducting seismic survey operations (Richardson, et al., 1995a; Richardson et al., 1995b). Vessels produce continuous low frequency sounds, frequently at 160 dB, that would be detected at sufficient distances to allow marine mammals to slowly move away from the vessel.

Firing airgun arrays produce pulsed sounds, typically in 8–14 second intervals, with most of the energy being released in a narrow frequency range. PSOs would be on duty during periods of airgun operation. NMFS uses a 160 dB sound source level as the standard to assess Level B harassment impacts. Estimates of incidental take by harassment are based upon the 160 dB level. PSOs will monitor the identified exclusion zones according to procedures outlined in the Incidental Take Authorizations (Incidental Harassment Authorization from NMFS and Letter of Authorization from USFWS) to minimize incidental takes and ensure that the Noticed Activities will not have more than a negligible level of effect on marine mammals.

In the case of whales or seals that do not avoid the approaching vessel and its various sound sources, operations procedures (identified in the IHA/LOA) would minimize effects of seismic sources to reduce or eliminate any potential effect on bowhead whales, ringed seals, or bearded seals are impacted. If a marine mammal nears or enters the exclusion zone, the seismic airgun array is powered or shut down. PSOs should initiate a power down before a marine mammal enters the exclusion zone. Shut downs are seldom required, as power downs reduce the size of the exclusion zone and most marine mammals avoid seismic operations vessels in open water.

Collisions. The absence of collisions involving industry vessels and marine mammals in the Arctic despite decades of spatial and temporal overlap suggests that the probability of collision is low (NMFS 2013). A collision between a seismic vessel and a slow-moving whale is very unlikely because seismic vessels move slowly, at survey speeds of around 5 kts, and do not change direction quickly. Vessels are directed via the IHA/LOA to avoid close approaches to marine mammals. Walruses and seals are highly agile in the water and very unlikely be injured by large slow-moving vessels. No vessel/marine mammal collisions are anticipated to occur during the Noticed Activities.

Species-Specific Effects

The eight marine mammal species most likely to be present in the project area during all or part of the noticed July through October survey period are bowhead whales, gray whales, beluga whales, bearded seals, ringed seals, spotted seals, walruses, and polar bears.

Bowhead Whale. The Noticed Activities would begin after most bowheads have migrated out of the Chukchi Sea and into the Beaufort Sea. Bowhead whales are responsive to noise in their environment, and their primary response to seismic surveys has been to avoid such operations, though

responses have varied. Vessel noise associated with the Noticed Activities should not affect bowheads because airgun noise would exceed the vessel noise, subsuming the vessel noise inside the larger envelope of airgun noise.

Typical monitoring and operational procedures as identified in the IHA are anticipated to reduce the potential for adverse impacts, including disturbance from vessel presence, vessel or airgun sounds, or collisions to a negligible level of effect to bowhead whales.

Gray Whale. Gray whales feed widely across the continental shelf waters of the Chukchi Sea but are most often observed in shallow and nearshore areas where they mostly feed on benthic species. Primary concentration areas on the Alaskan coast occur along the Chukchi Sea coast, particularly in protected waters and bays, and near the Barrow Canyon upwelling, north of Barrow, Alaska.

Gray whales are anticipated to be affected in a manner consistent with what has been described for bowhead whales. Low numbers of gray whales are expected to be encountered in the Chukchi Sea. Typical monitoring and operational procedures as identified in the IHA are anticipated to reduce the potential for adverse impacts, including disturbance from vessel presence, vessel or airgun sounds, or collisions to a negligible level of effect to gray whales.

Beluga Whale. Some belugas in the Chukchi Sea could be encountered during the Noticed Activities. The main fall migration corridor of beluga whales is ~100+ km north of the coast. Research has shown that belugas may be displaced by seismic noise (Erbe and Farmer, 2000), which may result in some increased energetic costs. However, belugas typically associate with sea ice in the Chukchi Sea and the Noticed Activities would operate to avoid sea ice. Any belugas in the vicinity of survey activities could be affected in the same manner as bowhead or gray whales. Typical monitoring and operational procedures as identified in the IHA are anticipated to reduce the potential for adverse impacts, including disturbance from vessel presence, vessel or airgun sounds, or collisions to a negligible level of effect to beluga whales.

Pacific Walrus. Vessel traffic could disturb walrus at sea and may briefly alter the movements or foraging of walrus by temporarily displacing some animals as vessels pass through an area. Such traffic is expected to have a short-term (a few hours to a few days) effect on walrus movements or distributions. Adult walrus and sub-adults have the ability to cover large distances in a relatively small amount of time. Walrus cows and calves usually concentrate near haulouts of residual sea ice or along the Chukchi coast. Repeated disturbances from vessel traffic could have energetic costs and has the potential to separate walrus calves from cows. Because of the expected lack of sea ice in most of the survey area during the open water season, and the distance between the survey area and coastal haulout sites, BOEM does not expect many walrus cow/calf pairs to be affected. Disturbance effects are likely to be limited to short term deflections from vessel/seismic activities.

Typical monitoring and operational procedures as identified in the LOA are anticipated to reduce the potential for adverse impacts, including disturbance from vessel presence, vessel or airgun sounds, or collisions to a minor level of effect to walrus, based on the assumption that there may be a large number of walrus moving through a portion of the survey area during a brief period of the Noticed Activities.

Bearded Seal. Bearded seals occur throughout the project area and some bearded seals could be encountered during the Noticed Activities. Based on past observations any effects from the Notice Activities would consist of disturbing or displacing bearded seals. Previous industry surveys noted bearded seal often responded by observing vessels from the sea surface as the vessels passed by the seal (Funk et al. 2010, Blees et al. 2011; Brueggeman 2009). NMFS uses the 160dB and 190 dB sound source level standards to respectively assess Level B and Level A harassment or potential injury levels to ice seals. NMFS (2013a) suggested bearded seals mostly remain unaffected by noises

up to 189 dB in intensity, implying injuries could only occur when noise levels equal or exceed 190 db (up to 180 - 600 m [590 – 1968 ft] from the airguns).

Typical monitoring and operational procedures as identified in the IHA are anticipated to reduce the potential for adverse impacts, including disturbance from vessel presence, vessel or airgun sounds, or collisions to a negligible level of effect to bearded seals.

Ringed Seal. Ringed seals are likely to be the most commonly encountered marine mammal during the Noticed Activities. Impacts to ringed seals should amount to brief disturbance or temporary displacement, consistent with those described for bearded seals. Typical monitoring and operational procedures as identified in the IHA are anticipated to reduce the potential for adverse impacts, including disturbance from vessel presence, vessel or airgun sounds, or collisions to a negligible level of effect to ringed seals.

Spotted Seal. Spotted seals are likely to be encountered during the noticed activities. The impacts to spotted seals should be similar to those described for bearded seals and ringed seals. Typical monitoring and operational procedures as identified in the IHA are anticipated to reduce the potential for adverse impacts, including disturbance from vessel presence, vessel or airgun sounds, or collisions to a negligible level of effect to spotted seals.

Polar Bear. Seismic operations are planned for the open water season when there is less than 10% ice cover in the survey area. Any polar bears encountered during the course of the noticed activities would most likely be swimming in open water. Polar bears typically swim with their heads above water, making them less susceptible to impacts from seismic airguns. Based on previous monitoring efforts for similar projects, BOEM anticipates that ships traversing open water will encounter few, if any, polar bears. The disturbance created by the presence and noise of seismic survey ships is brief. Typical monitoring and operational procedures as identified in the LOA are anticipated to reduce the potential for adverse impacts, including disturbance from vessel presence, vessel or airgun sounds, or collisions to a negligible level of effect to polar bears.

Summary of Effects

There are eight marine mammal species that could be in the Chukchi Sea when the ancillary activities are may occur. While there are relative differences to the number of each population that could be encountered by the seismic vessel during the Noticed Activities, potential adverse interactions for all species are reduced by typical monitoring and operational procedures as identified in the IHA and LOA. These are anticipated to reduce the potential for adverse impacts, including disturbance from vessel presence, vessel or airgun sounds, or collisions to a negligible level of effect for all marine mammals, with the exception of walrus. Walrus could be encountered more frequently during a brief migration during the open water season; the potential for adverse effects to walrus could reach a minor level of effect.

3.3.6.3. Cumulative Effects

Appendix B, Cumulative Effects Scenario, identifies other activities that could overlap in space and time with the Noticed Activities. The small number of vessels associated with the Noticed Activities would be insufficient to measurably add to the existing impacts of vessel traffic on marine mammals in the Chukchi Sea.

Few activities are occurring concurrently with the Noticed Activities in the Chukchi Sea. The TGS survey and the Shell ancillary activities would not operate in close proximity (within 15 mi) to each other. Taken together, airgun operations from the Noticed Activities, when combined with the TGS seismic survey would not appreciably raise the overall level of effects to marine mammals from seismic noise beyond negligible because the effects are concentrated on the vessel location, which is

typically moving slowly across open water. Noise effects are localized and do not persist across seasons.

Similarly vessel traffic and vessel noise levels have only had a negligible cumulative effect on marine mammals in the Chukchi Sea to date, while vessel collisions with marine mammals have not been documented.

Effects of climate change in the U.S. Chukchi Sea include loss of habitat for resting and foraging for polar bears, walrus, and ice seals. The Noticed Activities do not have a clear causal connection to climate change.

The Noticed Activities are not anticipated to appreciably add to the cumulative effect of climate change, airgun noise, vessel noise, vessel traffic, or collision risk to marine mammals in the Chukchi Sea.

3.3.7. Subsistence, Environmental Justice, Public Health, Economy, and Archaeological Resources

Subsistence activities are a critical element of North Slope Borough (NSB) social systems. Communities dependent on subsistence harvesting consider it a collective and cultural right (and duty) rather than an individual right since a limited number of individuals usually provide for the larger community (Ristroph, 2010). Subsequent sections of this EA will address specific components of socio-cultural and socio-economic resources of communities closest to the Noticed Activities, i.e. Wainwright and Point Lay. Other communities in the NSB with relatively close proximity the Noticed Activities include Barrow to the northeast and Point Hope to the southwest. Potential impacts of this Noticed Activities on subsistence, environmental justice, public health and the economy will be addressed in subsequent sections.

3.3.7.1. Affected Environment

Subsistence Activities

Subsistence activities are of high cultural value to Iñupiat of the North Slope. Subsistence activities provide a sense of identity and are an important economic pursuit. Subsistence is viewed by Alaska Natives not just as an activity that is embedded in the culture; it is viewed as the very culture itself (Wheeler and Thornton, 2005). Because subsistence plays such an important role in Alaska Native culture and society, a reduction (or even a perceived reduction) in the availability of subsistence foods impact food security and contributes to social pathology (Wernham, 2007). Wainwright and Point Lay are coastal communities situated approximately 3 to 134 miles from the Noticed Activities. Barrow and Point Hope are situated approximately 27 to 239 miles (+/-) from the Noticed Activities area (Table 4).

Table 4. Distances from the Coastline and Chukchi Sea Villages to Survey Areas.

Area	Barrow	Wainwright	Point Lay	Point Hope	Coastline
Ice Gouge	27 mi (44 km)	3.0 mi (4.8 km)	50 mi (81 km)	206 mi (332 km)	>3.0 mi (4.8 km)
Survey Area 1: Crackerjack	191 mi (307 km)	134 mi (216 km)	117 mi (188 km)	173 mi (278 km)	106 mi (171 km)
Survey Area 2: Burger	132 mi (213 km)	73 mi (117 km)	93 mi (150 km)	206 mi (332 km)	59 mi (95 km)
Survey Area 3: NE of Burger	103 mi (166 km)	63 mi (102 km)	118 mi (190 km)	239 mi (385 km)	60 mi (96 km)

Note: Distances are to nearest Location within the Survey Area.

Iñupiat marine subsistence harvest activities have been identified to occur approximately 20 miles offshore in these communities (WTC, 2008: Map 1). Iñupiat whaling traditions are unquestionably important and harvest of other wild resources including other marine mammals, fish, birds, and land

based animals are important to local communities by providing dietary variety and nutrition, as well as providing long-term, sustainable nutritional needs when few or no bowhead whales are taken.

Subsistence Communities

This discussion will focus on subsistence resources and activities at Wainwright and Point Lay. Further discussion will include identification of subsistence resource and harvest activities at Point Hope and Barrow.

Wainwright. The Village of Wainwright located on the Chukchi Sea approximately 72 miles southwest of Barrow lies along a wave-eroded coastal bluff on the west side of a narrow peninsula which separates Wainwright Inlet from the Chukchi Sea. Wainwright residents rely on a variety of both marine and terrestrial subsistence resources throughout the year and subsistence-harvest areas are depicted in detail in the Wainwright Traditional Council's Conservation Plan Map Book 2008 (WTC, 2008). Marine and land based animals such as bowhead whale, seals, walrus, salmon and other fish along with land based animals comprise a significant portion of Wainwright residents' subsistence diet (WTC, 2008). A survey found that over 90-percent of Wainwright households depend on subsistence foods to some extent and nearly one-third of households depend on subsistence foods for more than half of their annual nutrition (NSB, 2004).

Point Lay. The Village of Point Lay is located on the Chukchi Sea coast 150 miles southwest of Barrow. Point Lay is protected from the open ocean by the Kasugaluk Lagoon, an area where traditional hunting of beluga whales occurs each year in July. Point Lay also utilizes other migratory animals for subsistence resources. Residents harvest whales, seal and fish along with land based animals. Approximately 77-percent of the households in Point Lay participate in the local subsistence economy and of those households, 75-percent are heavily reliant on subsistence resources, where one-half or more of household diets consisted of local resources (Shepro, Maas et al. 2003).

Barrow. Barrow is the economic, transportation and administrative center for the North Slope Borough. Located on the Chukchi Sea coast 300 miles (480 km) north of the Arctic Circle, Barrow is the northernmost community in the United States. Barrow residents, like those in Wainwright and Point Lay, rely on marine animals, fish, birds, and land based animals for subsistence. During some harvest years, marine mammal harvests accounted for up to 73-percent of the total subsistence harvest in Barrow (SRB&A, 2010).

Point Hope. Point Hope is located 250 miles southwest of Barrow on a triangular spit of land that extends 15 miles into the Chukchi Sea. Point Hope uses marine waters of the Chukchi Sea for purposes of subsistence hunting and harvesting. Subsistence activities throughout the year revolve around whales, other marine animals, fish, and land based animals. Approximately 93-percent of households in Point Hope participate in the local subsistence economy (Shepro, Maas et al. 2003). Subsistence lifestyle remains a primary cultural choice of Point Hope residents with approximately two-thirds of all Point Hope residents obtaining half or more of their diet from local subsistence resources (Shepro, Maas et al. 2003).

Subsistence Resources

The following describes important subsistence resources along with the four villages' use of each resource.

Whales (Bowhead and Beluga)

Bowhead (Aãviq) and beluga (Qiøalugaq) whales are subsistence resources of paramount importance. Consequently, descriptions of the social organization pertaining to whaling crews, the hunt, quantity, and distribution of whales dominate subsistence discourse in NSB Iñupiat Eskimo communities (AEWC, 2012). Whaling as a subsistence activity underscores cultural and economic life of Arctic Villages with harvest occurring primarily during spring and summer months in all four communities

(AEWC, 2012). Wainwright and Barrow harvest April through May (Bowhead) and June through August (Beluga) with Point Lay and Point Hope harvesting April through June (Bowhead) and mid-June through mid-July (Beluga). Wainwright conducts a fall hunt for Bowhead whales in October. Harvest locations are approximately 10 to 15 miles (16 km to 24 km) offshore into the Chukchi Sea. Locations of harvest also include coastal lagoons for Wainwright and Barrow, Point Lay hunters harvest as far offshore as 20 miles (32km), and Point Hope harvest in open waters near shorelines (Bacon et. al., 2009). Migration and characteristics of bowhead and beluga whales are discussed in Section 3.2.6. Whaling traditions, unquestionably important, do not minimize harvest of other resources including other marine mammals, fish, birds, and land based mammals important for Iñupiat diet and nutrition if few or no bowhead whales are taken (Applied Sociocultural Research, 2010).

Seal (Ringed, Spotted, and Bearded)

In late spring during break up, ring seal (natchiq) may disappear and be replaced by spotted seal (qasigiaq). Spotted seal and bearded seal (Ugruk) are most prevalent during the summer (Lowenstein, 1980; Ivie & Schneider, 1988). Spotted seal gather on shallow spits and bays west of Wainwright and hunters consider late summer and fall to take seals when they are fat and will float after being killed (Lowenstein, 1980). Most Wainwright seal harvests are taken in Kuk Lagoon but may travel offshore as far 40 miles (64km). Bearded seals are taken along the coast but are often hunted to the west of Wainwright during July through August (SRB&A, 2012). Point Lay residents primarily hunt ringed and spotted seals. Ringed seal, available throughout most of the year, is difficult to locate in ice-free months when pack ice is farther offshore (July and August). The peak of ring seal harvest occurs from April through June. Ring seal is sometimes taken incidentally to walrus and bearded seal harvests in June and July around Point Lay. For Point Lay, the majority of bearded seals are harvested in June and sometimes as late as August if hunters follow ice north. Bearded seal hunting usually takes place 5 to 6 miles (8-10km) offshore, but hunters may go farther out as they look for walrus. In Barrow, seals are the second most commonly harvested mammal after bowhead whales (SRB&A, 2010). Seal hunting for Barrow residents occurs both close to shore during winter and spring and in the open ocean during the months of June through August. Hunters travel from 30 to 60 miles (48-96 km) to take seals with distances varying year to year due to changing conditions and weather. Bearded seals are harvested June through August. Point Hope, after whaling season, turns their attention to hunting seal hunting. In June and July seal may be found on ice flows directly in front of the coastal village of Point Hope. Traditionally, residents of Point Hope have regarded the southern portion of the Chukchi Sea as an area of particular abundance when subsistence harvesting (Ivie and Schneider, 1980).

Walrus

Walrus (Aiviq) hunting occurs in the Chukchi Sea for Wainwright residents south to Point Lay June through August and along the coast near the village. Point Lay hunters also harvest walrus June through August. Walrus take are between Cape Beaufort and Icy Cape with hunters traveling offshore approximately 25 miles (40 km). In Barrow, walrus harvest occurs July and August and coincides with the bearded seal hunt (SRB&A, 2010). Hunters in Barrow commonly travel no farther than 40 or 50 miles (64-80 km) offshore to subsistence use areas (SRB&A, 2012). Point Hope harvests May to July up to 20 miles (32 km) offshore between Cape Thompson and Cape Lisburne.

Fish (Salmon, Lingcod, Trout, Grayling, Smelt, Tom Cod)

Fish are an important subsistence resource and an economic resource to these communities. Many of these fish are harvested in rivers, but many are harvested in coastal waters and in open waters as well. Fish such as salmon, lingcod, trout, Arctic grayling, and smelt are just a few of the species harvested by these four communities.

Environmental Justice

Executive Order 12898 (EO), “*Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*,” requires that each Federal agency consider environmental justice to be part of its mission to evaluate whether proposed projects would have “disproportionately high adverse human health and environmental effects on minority populations and low income populations.” Its intent is to promote fair treatment to people of all races, so no person or group of people bears a disproportionate share of the negative effects from the country’s domestic and foreign programs. According to the 2010 Census 90.1% of the population (556 residents) of Wainwright, 88.4% (189 residents) of Point Lay, 61.2% (4,212 residents) of Barrow, and 89.5% (674 residents) of Point Hope are Alaska Native (specifically Iñupiat) or American Indian, an identified minority group, thus meeting the 50% population threshold of an affected area under the environmental justice criteria (U.S. Census, 2010).

For centuries, survival in the Arctic has centered on the pursuit of subsistence foods and materials and the knowledge needed to harvest these resources. Development of Iñupiat culture depends on passing on traditional knowledge and beliefs about subsistence resources. This knowledge includes observations of game behavior, how to use those observations to successfully locate and harvest game, and how hunters and their families should behave to ensure successful harvests in the future. (Spencer 1976). For Iñupiat, subsistence and culture continue to be inextricably intertwined.

Although there have been substantial social, economic, and technological changes in Iñupiat lifestyle, subsistence continues to be the central organizing value of Iñupiat sociocultural systems. Iñupiat remain socially, economically, and ideologically loyal to their subsistence heritage. Large amounts of subsistence foods are shared within and between the communities and the people one gives to and receives from are major components of what comprises significant kin ties (Heinrich 1963). Disruption of subsistence harvest patterns could alter these cultural values and affect community social structure.

Public Health

Before non-natives arrived in Alaska, Alaska Natives work consisted in catching, hunting and gathering their next meal. Life and resulting good health were based on subsistence. Harold Napoleon, of Hooper Bay, said of subsistence: “Our belief system - the way our creator spoke to us was through his own creation - through the animals and the fish; we not only hunt and we eat. That’s the way he spoke to us was through nature. So when we participate in subsistence it’s like reaffirming who we are.” Subsistence is not only an important cultural right, it keeps communities healthy and provides food in otherwise economically disadvantaged areas.

Good health is essential to cultural sustainability and socio-economic development. A healthy community is the infrastructure upon which is built an economically viable society. Good health is a prerequisite to human productivity and development (Basavanthappa, 2008). Communities are composed of a number of sub-systems. They are social systems with their own pattern of interaction that results from interrelationships of many systems within each community. Individual status, roles, and positions function together in an attempt to achieve a certain goal of these systems, as evidenced by subsistence whaling crew structures in Iñupiat society. Subsistence food gathering is not only central to Iñupiat culture, but also to survival and good health (GAO, 2009).

Socio-cultural identities incorporate traditions values, norms, and sanctions that are accepted and reinforced by the people. This identity influences lifestyles and priorities placed on various elements of life such as subsistence harvests. Prevailing attitudes and values about health and illness and about traditional medicines are directly associated with a community’s health. “Subsistence has value beyond the food it produces. It is more than economics. It is the well-being of the community.”

(Mary Pete, quoted in *The Juneau Empire* Juneau: 11/16/1999). It is essential to Native ways of life, essential for cultural survival (Alaska Natives Commission, 1994; Morehouse & Holleman, 1994).

Villages have small cash economies and limited work opportunities. The high cost of fuel and transporting food to rural communities makes store bought food more expensive (Table 5).

Table 5. July 2012: Gasoline Prices per Gallon across Alaska.

Gulf Coast	Interior	Northern	Northwest	Southeast	Southwest	Western	Impact Level
\$7.13	\$10.00	\$9.65	\$7.60	\$6.01	\$9.09	\$8.03	High
\$4.15	\$4.08	\$5.00	\$5.00	\$3.92	\$4.70	\$6.00	Low
\$5.31	\$6.12	\$6.35	\$6.36	\$4.74	\$6.23	\$6.91	Average

Source: Current Community Conditions- Alaska Fuel Price Report July 2012:
http://www.commerce.state.ak.us/dca/pub/Fuel_Report_2012_July.pdf.

As illustrated above, average gasoline prices per gallon vary across Alaska by region creating higher food prices which directly impact health. Communities in the NSB report average gasoline retail prices at \$6.35 to \$6.36 per gallon. If there is a real or perceived decrease in subsistence harvests coupled with higher food prices, this can result in the availability of less nutritious foods and resulting “food deserts”.

According to the NSB, the cost of living in Barrow is 278-percent higher than the cost of living in the lower 48. In 2010 it was stated that “not only is hunting an essential part of the culture, it’s a necessary alternative to high food prices”. In the local market, a loaf of white bread was \$5.39 and a quart of milk \$3.95.

The lack of accessibility to a variety of reasonably priced nutritious and fresh foods or subsistence harvest foods can be an obstacle to achieving a recommended diet (Block and Kouba, 2005). Research shows that a proportion of food costs are greater for people living in low income communities. This issue in the NSB plays a role in environmental justice, public health, and economic sustainability. In some communities research has shown that there is an association between under-nutrition, malnutrition and high obesity rates to decreased economic and social resources (Black and Macinko, 2008).

Shell-proposed Mitigation Measures for Subsistence Activities

Shell proposes timing of its survey operations to avoid affecting subsistence harvests for NSB communities who utilize the Chukchi Sea for resources. Shell has incorporated mitigation in their Noticed Activities to lessen or alleviate impacts associated with its surveys on subsistence activities.

In addition, provisions of the NMFS IHA and FWS LOA (as authorized by the Marine Mammal Protection Act) require activities to have no non-mitigable adverse effects on subsistence harvests. The provisions of Shell’s IHA from NMFS and those from the LOA from FWS, and their associated plans of cooperation, would ensure that only small numbers of marine mammals would be affected.

Economy

OCS oil and gas activities generate economic effects on the NSB, State of Alaska, and the Federal government in the form of direct and indirect employment, personal income associated with employment, and various types of revenues accruing to each level of government. The NSB receives revenues primarily from property taxes from high value onshore oil and gas infrastructure. The State of Alaska receives revenues from oil and gas activities in the form of property taxes, state corporate income tax, revenues associated with the Trans-Alaska Pipeline System (TAPS), 8(g) revenue. Oil and gas activities generate revenues for the Federal government through royalties, bonus bids, and rental revenues.

The NSB is a mixed economy, characterized by a traditional cash economy and subsistence economy. The NSB economy is characterized by high unemployment and underemployment. Training programs and workforce development will continue to be important in the future to increase the low number of NSB residents that receive employment and personal income in the oil industry. More local hire would increase employment and personal income benefits from oil and gas activities within the local communities.

3.3.7.2. Direct and Indirect Effects

Shell plans to enter U.S. waters of the project area between mid-July through mid-October 2013. Seismic data acquisition is planned to begin around these dates with as little as 13 days of ice gouge survey operations and shallow hazard surveys at 50+ days. The July entry was in response to concerns voiced by the local communities of Wainwright and Point Lay. These communities requested entry into the Chukchi Sea be delayed until after the walrus and beluga whale hunts are completed in the area.

Subsistence Activities

With Shell's proposed mitigation and IHA mitigation in place the noticed activities have potential for negligible to minor impacts to summertime marine subsistence hunts. Marine effects from the project in the Chukchi Sea should not be long-term but will be limited to the season in which the seismic work is conducted; July-October, 2013.

Environmental Justice

Executive Order 12898 sets thresholds on adverse impacts which have "disproportionately high and adverse human health or environmental effects on minority and low income populations".

The Noticed Action will have a negligible level of effect. It does not have the potential to have significant long-term direct and indirect effects on Environmental Justice.

Public Health

The impacts on public health are negligible. There will be short-term effects that will not disrupt normal or routine community functions. There will be no long-term consequences for public health or wellbeing.

Economy

The proposed activities are short term and temporary, involving low levels of new employment and associated income and no generation of property tax revenues accruing to the NSB or State of Alaska, and are therefore expected to have a negligible cumulative effect on employment, income, and revenue levels of the NSB.

Archaeological Resources

The Noticed Activities will have no effect on cultural resources. No geotechnical work will be performed and no land based activities have been identified in the Notice or EED (Shell, 2013a, b). No further analysis will be required. For further information, see Section 4.4.

3.3.7.3. Cumulative Effects

Subsistence

Cumulative impacts of Alternative 2 on subsistence marine hunting will be negligible due to the limited spatial and temporal perturbations of marine mammals. If the Noticed Activities are conducted, no effects should be felt beyond the life of this action. The Noticed Activities will have no long-term impact on species or future subsistence harvest once work is completed.

Public Health

This action will have no long term consequences to public health and well-being in NSB communities. Therefore, the incremental impact of the Noticed Activities on public health would also be negligible to minor.

Environmental Justice

The Noticed Activities do not have the potential to have significant cumulative effects on Environmental Justice.

Economy

The cumulative impact of the Noticed Activities is also expected to be negligible.

Archaeological Resources

The Noticed Activities will have no cumulative effects on archaeological resources.

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4.0 CONSULTATION AND COORDINATION

4.1. Endangered Species Act Consultation

Section 7(a)(2) of the ESA requires each Federal agency to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the adverse modification of designated critical habitat. BOEM consults with USFWS and NMFS for listed species under each Service's jurisdiction.

The USFWS issued a Biological Opinion and Conference Opinion to BOEM for oil and gas activities in the Beaufort and Chukchi Sea Planning Areas for polar bears, polar bear critical habitat, spectacled eiders, spectacled eider critical habitat, Steller's eiders, Kittlitz's murrelets, and yellow-billed loons on May 8, 2012 (USFWS, 2012). BOEM notified USFWS that with the addition of minor technical changes concerning bird encounters with vessels, Shell would be consistent with the Noticed Activities described in the Biological Opinion. In that notification to USFWS, BOEM believed it fulfilled its obligations under the ESA for the Shell project, and no further action was required.

The NMFS issued on April 2, 2013, to BOEM a programmatic Biological Opinion (NMFS, 2013). The effect of seismic survey activities on bowhead whales, fin whales, and humpback whales, North Pacific right whales, Arctic ringed seals, and Beringia DPS bearded seals were analyzed in the Biological Opinion on Oil and Gas Leasing and Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska. On June 5, 2013, BOEM notified NMFS that Shell's noticed activities were analyzed by the existing Biological Opinion, and BOEM believed it fulfilled its obligations under the ESA for the Shell project and no further action is required.

4.2. Essential Fish Habitat Consultation

In accordance with the Magnuson-Stevens Fishery Conservation and Management Act of 1976, as amended, federal agencies are required to consult with NMFS on any action that may adversely affect designated EFH within or near the action area. The consultation includes an assessment of EFH within the Noticed Activities area and a description of measures to avoid, minimize, or otherwise offset potential adverse effects to the designated EFH. BOEM is consulting with NMFS on these Noticed Activities through a separate document (Essential Fish Habitat Assessment: Arctic Cod, Saffron Cod, Opilio crab; Ancillary Activities in the Northeastern Chukchi Sea, Shell Gulf of Alaska, 2013) (USDOJ, BOEM, 2013).

4.3. Marine Mammal Protection Act

Shell has committed to obtaining incidental take authorizations (ITA) in the form of an Incidental Harassment Authorization (IHA) from NMFS and a Letter of Authorization (LOA) from USFWS. ITA mitigation and monitoring requirements are generally intended to limit potential adverse impacts to marine mammals to a negligible level of effect and preclude unmitigable impacts to subsistence uses. The MMPA requires that authorized activities have no unmitigable adverse impact on subsistence uses of marine mammals.

The Noticed Activities will incorporate mitigation measures from their December 26, 2012, and April 9, 2013, IHA application and revision to NMFS. The Noticed Activities also incorporate mitigation measures from the January 22, 2013, and April 9, 2013, LOA request and revision to USFWS. Those measures include Shell's Marine Mammal Monitoring and Mitigation Plans.

4.4. Archaeological Resources

The Noticed Activities do not include any bottom-disturbing activities or any other activities with the potential to affect historic resources as defined under the National Historic Preservation Act (NHPA).

BOEM consideration of the Noticed Activities therefore does not require consultation under Section 106 of the NHPA.

4.5. Public Involvement

Public participation regarding the Noticed Activities has been provided for through a combination of public notification of BOEM's receipt of the ancillary activities notice for marine surveys in the Chukchi Sea and a public notice of BOEM's intent to prepare an EA. On Wednesday, May 22, 2013, BOEM posted a request for public input on preparation of this Environmental Assessment for a Shell 2013 Geological and Geophysical (G&G) Ancillary Activity in the Chukchi Sea Outer Continental Shelf. The notice was posted to the BOEM Alaska website (<http://www.boem.gov/About-BOEM/BOEM-Regions/Alaska-Region/Community-Liaison/Public-Involvement-2013-Open-Water-Season.aspx>), and at [Regulations.gov](http://www.regulations.gov). Comments were accepted at [Regulations.gov](http://www.regulations.gov) through midnight June 5, 2013. BOEM received one comment from a private citizen. The comment is available to view at: <http://www.regulations.gov/#!documentDetail;D=BOEM-2013-0032-0002>.

4.6. Reviewers and Preparers

The persons responsible for the review of Shell's Noticed Activities, supporting information and analyses, and preparation of this EA are listed below:

Name	Title
Gene Augustine	Biologist
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Bill Swears	Technical Editor
Jen Youngblood	Sociocultural Specialist

GLOSSARY

Airgun: An airgun is a device that releases compressed air into the water column, creating an acoustical energy pulse with the purpose of penetrating the seafloor.

Cryosphere: the places on surface of the Earth where water is in its solid form, where low temperatures freeze water and turn it into ice.

Exclusion Zone: Also synonymously referred to as a safety zone within the Shell source material, the exclusion zone is an area around the seismic-survey-sound source within a designated sound-level isopleth wherein marine mammals may be exposed to sounds that are considered a Level A take by NMFS. The exclusion zones are based on sound levels of 180 dB (for cetaceans and walrus) and 190 dB (for ice seals and polar bears). The exclusion zones must be clear of marine mammals prior to survey commencement, and must remain free of marine mammals during survey operations.

Harrassment: The MMPA defines “harrassment” as “any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harrassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harrassment].”

Isopleth: A line on a map connecting points at which a given variable has a specified constant value. For seismic surveying, isopleths connect points of equal sound level (e.g. 160 dB, 180 dB, 190 dB).

Power-down Procedure: Reduction of the sound output of the airgun array to a level that would avoid exposing any marine mammal to the 180 or 190 dB (depending upon the species) exclusion zone.

Protected Species Observer (PSO): Formerly Marine Mammal Observer (MMO). PSOs are trained observers whose responsibilities are to observe, record, and inform the vessel crew of any sighted protected species. PSOs vessel duties include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the survey operations; and documenting “take by harrassment” as defined by NMFS and/or USFWS.

Ramp-up Procedure: Ramp-up of an airgun array consists of a gradual increase in sound level and a step-wise increase in the number and total volume of airguns firing until the full volume is achieved. The intent of ramp-up is to “warn” marine mammals in the vicinity of the airguns and to allow sufficient time for those animals to leave the area and avoid any potential injury or impairment of their hearing. Under normal conditions, animals sensitive to these activities are expected to move out of the area. Seismic surveys, including airgun testing or tuning, use the ramp-up procedures described below to allow whales and other marine mammals to depart the exclusion zone before seismic surveying begins.

Ramp-up procedures during seismic survey operations are as follows.

- Visually monitor the entire full array exclusion zone and adjacent waters for the absence of marine mammals for at least 30 min before initiating ramp-up procedures. If no marine mammals are detected, (15 min for ice seals and polar bears or 30 min for baleen whales and Pacific walrus), ramp-up procedures may be initiated.
- Initiate ramp-up by firing a single airgun, preferably the smallest in terms of energy output (dB) and volume.
- Continue ramp-up by gradually activating additional airguns over a period of at least 20 min, but no longer than 40 min, until the desired operating level of the airgun array is obtained.

Safety Zone: see Exclusion Zone.

Shut-down Procedure: Airgun operations may not be conducted when marine mammals are present within the exclusion zone. If a marine mammal is seen swimming toward the exclusion zone, the airguns may first be powered down to avoid exposing the marine mammal to the 180/190 dB level, depending on species. If the animal reaches the single airgun exclusion zone, the array must be shut down. Likewise, if a marine mammal surfaces within single airgun exclusion zone, the seismic survey must be shut down. If the airgun array is shut-down for any reason during darkness or poor weather, it may not be re-energized until conditions allow for the exclusion zone to be effectively monitored.

Start-up Procedure: Start-up is the initiation of airgun activity preparatory to ramp-up (either initial operation in the survey area, or subsequent to a shut-down). Start-up of airgun operations may not commence unless the 180 dB exclusion zone has been visible for at least 30 min prior to start-up, and no marine mammals are observed within the exclusion zone for 15 min (ice seals and polar bears) or 30 min (baleen whales and Pacific walrus). If the array is shut-down pursuant to observation of a marine mammal, airgun operations may resume after the mammal has been observed to clear the exclusion zone for single airgun actuation or no marine mammals are observed within the exclusion zone for 15 min (ice seals and polar bears) or 30 min (baleen whales and Pacific walrus).

Take/Taking: The term “take” under the MMPA means “to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal.” Under the MMPA, the ‘taking’ of marine mammals, incidental or otherwise, without a permit or exemption is prohibited, with a few exceptions. One such exception (as stated in Sections 101(a)(5)(A) and (D)) is for the incidental, but not intentional, “taking,” by U.S. citizens, while engaging in an activity (other than commercial fishing) of small numbers of marine mammals of a species or population stock provided that the taking will have a negligible impact on such species or stock, will not have an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses, and the permissible methods of taking and requirements pertaining to the mitigation, monitoring, and reporting are set forth. Additionally, pursuant to Section 101(a)(5)(D) of the MMPA monitoring plans are required to be independently peer reviewed where the proposed activity may affect the availability of a species or stock for taking for subsistence uses.

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APPENDIX A – SHELL ANCILLARY ACTIVITIES
LEVEL OF EFFECTS DEFINITIONS AND ABBREVIATIONS

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1. Introduction

This appendix defines and explains the levels of effect used in the EA to evaluate potential environmental impacts. Impacts are described in terms of frequency, duration, general scope, and/or size and intensity. Each level considers such factors as the nature of the impact, the spatial extent, recovery times, and the effects of mitigation. The terms negligible, minor, moderate, and major are used to describe the relative degree or anticipated level of effect of an action on a specific resource. Following each term listed below for a specified resource are the general characteristics used to determine the anticipated level of effect. For each term, best professional judgment was used to evaluate the best available data concerning the affected resource.

For each resource, a “significance threshold” is also provided. Adverse impacts that do not meet the significance threshold are considered “not significant.” Required mitigation measures may reduce otherwise “significant” impacts to a level of “not significant.”

The absence of a significant effect does not equate to “no effect.” As shown in the four-category scale, and in the numerous analyses that BOEM has undertaken, effects from activities can be adverse and noticeable before they reach the significance threshold. Furthermore, in the cumulative effects analysis, BOEM analyzes the combined effects of projected activities with other actions, because BOEM recognizes that effects that individually do not reach this significance threshold may exceed that significance threshold when considered collectively.

2. Levels of Effect

2.1 Air Quality

The levels of effect applied to the air quality analysis are based on the results of two levels of analyses, the emission inventory, and if required, the more rigorous ambient air analysis based on computer dispersion modeling.

2.1.1 Significance Threshold

A significant effect on air quality is determined when

1. Project-related emissions cause an increase in pollutant concentrations over the nearest onshore area of at least 20 square kilometers that
 - a. exceeds half of any of the National Ambient Air Quality Standards (NAAQS) (except for ozone); or
 - b. exceeds half of the maximum allowable increase for any pollutant for the Prevention of Significant Deterioration (PSD) for a Class II area under 40 CFR 52.21(c) or 18 AAC 50.020(b); or
 - c. is expected to exceed half the ozone NAAQS based on an analysis of the potential increase in the ozone precursor emissions of volatile organic compounds (VOC) and nitrogen oxides (NOX); or
2. Design concentrations violate the NAAQS or if applicable, the Alaska Ambient Air Quality Standards (AAQS).

2.1.2 Level of Effects

Negligible

- Emission rates would be less than 100 tons per year for VOCs and all pollutants regulated under the NAAQS, and, if applicable, the Alaska AAQS.

Minor

- Emission rates would be equal to or greater than 100 tons per year for VOCs and all pollutants regulated under the NAAQS, and, if applicable, the Alaska AAQS.

Moderate

- Project-related emissions cause pollutant concentrations of at least one pollutant to exceed one-half of the PSD maximum allowable increases; or
- Project-related emissions cause pollutant concentrations of at least one pollutant to exceed one-half of the NAAQS, and, if applicable, the Alaska AAQS; or
- Increases in emissions of NO_x and VOC would result in the formation of ozone to a level that would be expected to exceed one-half the ozone NAAQS.

Major

- Design concentrations of at least one pollutant would equal or exceed one-half the NAAQS, and, if applicable, one-half the Alaska AAQS; or
- Increases in emissions of NO_x and VOC would result in the formation of ozone to a level that would be expected to equal or exceed the ozone NAAQS.

2.2 Water Quality

The levels of effect applied to water quality analysis consider the context and intensity of impacts, EPA's NPDES permitting program, and criteria under 40 CFR 125.122:

1. The quantities, composition and potential for bioaccumulation or persistence of the pollutants to be discharged;
2. The potential transport of such pollutants by biological, physical or chemical processes;
3. The composition and vulnerability of the biological communities which may be exposed to such pollutants, including the presence of unique species or communities of species, the presence of species identified as endangered or threatened pursuant to the Endangered Species Act, or the presence of those species critical to the structure or function of the ecosystem, such as those important for the food chain;
4. The importance of the receiving water area to the surrounding biological community, including the presence of spawning sites, nursery/forage areas, migratory pathways, or areas necessary for other functions or critical stages in the life cycle of an organism.
5. The existence of special aquatic sites including, but not limited to marine sanctuaries and refuges, parks, national and historic monuments, national seashores, wilderness areas and coral reefs;
6. The potential impacts on human health through direct and indirect pathways;
7. Existing or potential recreational and commercial fishing, including finfishing and shellfishing;
8. Any applicable requirements of an approved Coastal Zone Management plan;
9. Such other factors relating to the effects of the discharge as may be appropriate;
10. Marine water quality criteria developed pursuant to section 304(a)(1).

2.2.1 Significance Threshold

Significant effect on water quality is determined by any of the following: (1) the action is likely to violate its National Pollution Discharge Elimination System permit; (2) in the event of an accidental spill of crude oil or refined oil, total aromatic hydrocarbon or total aqueous hydrocarbon criteria for the Alaska marine or fresh-water quality standards are exceeded; or (3) the action is otherwise likely to introduce changes in the physical, chemical, or biological characteristics of a waterbody which

case an unreasonable degradation of the marine environment as defined at 40 CFR 125.121 and determined in accordance with 40 CFR 125.122.

2.2.2 Level of Effects

Negligible:

- Temporary and localized impacts to water quality that do not cause an unreasonable degradation under 40 CFR 125.122.

Minor:

- Long-term and/or widespread impacts to water quality that do not cause an “unreasonable degradation” under 40 CFR 125.122.

Moderate:

- Impacts to water quality that exceed NPDES permit criteria or cause a temporary or localized “unreasonable degradation” under 40 CFR 125.122.

Major:

- Impacts to water quality that cause long-term and widespread “unreasonable degradation” under 40 CFR 125.122.

2.3 Lower Trophic Organisms

2.3.1 Significance Threshold

An adverse impact that results in a decline in abundance and/or change in distribution requiring three or more generations for the indicated population to recover to its former status.

2.3.2 Level of Effects

Negligible:

- No measurable impacts. Population-level effects are not detectable.
- Localized, short-term disturbance or habitat effect experienced during one season that is not anticipated to accumulate across multiple seasons.
- No population level impacts to reproductive success or recruitment are anticipated.
- Mitigation measures are implemented fully and effectively or are not necessary.

Minor:

- Population-level effects are not detectable.
- Widespread annual or chronic disturbances or habitat effects not anticipated to accumulate across 1 year, or localized effects that are anticipated to persist for more than 1 year.
- Mitigation measures may be implemented on some, but not all, impacting activities, indicating that some adverse effects are avoidable.
- Unmitigatable or unavoidable adverse effects are short term and localized.

Moderate:

- Disturbances could occur, but not on a scale resulting in population-level effects.
- Widespread annual or chronic disturbances or habitat effects could persist for more than one year and up to a decade.

- Widespread implementation of mitigation measures for similar activities may be effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are short term and widespread, or long term and localized.

Major

- Disturbances occur that result in measurable population-level effects.
- Widespread seasonal, chronic, or effects from subsequent seasons are cumulative and are likely to persist for more than 1 decade.
- Mitigation measures are implemented only for a small portion of similar impacting activities, but more widespread implementation for similar activities could be more effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are widespread and long lasting.

2.4 Fish**2.4.1 Significance Threshold**

An adverse impact that results in a decline in abundance and/or change in distribution requiring three or more generations for the indicated population to recover to its former status.

2.4.2 Level of Effects**Negligible:**

- No measurable impacts. Population-level effects are not detectable.
- Localized, short-term disturbance or habitat effect experienced during one season that is not anticipated to accumulate across multiple seasons.
- No mortality or impacts to reproductive success or recruitment are anticipated.
- Mitigation measures are implemented fully and effectively or are not necessary.

Minor:

- Population-level effects are not detectable. Temporary, nonlethal adverse effects to some individuals.
- Widespread annual or chronic disturbances or habitat effects not anticipated to accumulate across 1 year, or localized effects that are anticipated to persist for more than 1 year.
- Low mortality levels may occur, measurable in terms of individuals or <1% of the local post-breeding fish populations.
- Mitigation measures may be implemented on some, but not all, impacting activities, indicating that some adverse effects are avoidable.
- Unmitigatable or unavoidable adverse effects are short term and localized.

Moderate:

- Mortalities or disturbances could occur, but not on a scale resulting in population-level effects.
- Widespread annual or chronic disturbances or habitat effects could persist for more than 1 year and up to a decade.

- Some mortality could occur but remains limited to a number of individuals insufficient to produce population-level effects.
- Widespread implementation of mitigation measures for similar activities may be effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are short term and widespread, or long term and localized.

Major

- Mortalities or disturbances occur that have measureable and thus significant population-level effects.
- The action may adversely affect an endangered or threatened species or its habitat in a way that has been deemed to be critical under the Endangered Species Act of 1973.
- For fishes, the anticipated mortality is estimated or measured in terms of tens of thousands of individuals or >20% of a local breeding population and/or >5% of a regional population, which may produce short-term, localized, population-level effects.
- Widespread seasonal, chronic, or effects from subsequent seasons are cumulative and are likely to persist for more than 1 decade.
- Mitigation measures are implemented only for a small portion of similar impacting activities, but more widespread implementation for similar activities could be more effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are widespread and long lasting.

2.5 Marine and Coastal Birds

2.5.1 Significance Threshold

Threatened and Endangered Species: An adverse impact that results in a decline in abundance and/or change in distribution requiring one or more generation for the indicated population to recover to its former status.

All Other Marine and Coastal Birds: An adverse impact that results in a decline in abundance and/or change in distribution requiring three or more generations for the indicated population to recover to its former status.

2.5.2 Level of Effects

Negligible

- Localized short-term disturbance or habitat effect experienced during one season that is not anticipated to accumulate across one year.
- No mortality is anticipated.
- Mitigation measures implemented fully and effectively or are not necessary.

Minor

- Widespread annual or chronic disturbances or habitat effects not anticipated to accumulate across one year, or localized effects that are anticipated to persist for more than 1 year.
- Anticipated or potential mortality is estimated or measured in terms of individuals or <1% of the local post-breeding population.

- Mitigation measures are implemented on some, but not all, impacting activities, indicating that some adverse effects are avoidable.
- Unmitigatable or unavoidable adverse effects are short-term and localized.

Moderate

- Widespread annual or chronic disturbances or habitat effects anticipated to persist for more than one year, but less than a decade.
- Anticipated or potential mortality is estimated or measured in terms of tens or low hundreds of individuals or <5% of the local post-breeding population, which may produce a short-term population-level effect.
- Mitigation measures are implemented for a small proportion of similar impacting activities, but more widespread implementation for similar activities likely would be effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are short-term but more widespread.

Major

- Widespread annual or chronic disturbance or habitat effect experienced during one season that would be anticipated to persist for a decade or longer.
- Anticipated or potential mortality is estimated or measured in terms of hundreds or thousands of individuals or <10% of the local post-breeding population, which could produce a long-term population-level effect.
- Mitigation measures are implemented for limited activities, but more widespread implementation for similar activities would be effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are widespread and long lasting.

2.6 Marine Mammals

2.6.1 Significance Threshold

Threatened and Endangered Species: An adverse impact that results in a decline in abundance and/or change in distribution requiring one or more generation for the indicated population to recover to its former status.

All Other Marine Mammals: An adverse impact that results in a decline in abundance and/or change in distribution requiring three or more generations for the indicated population to recover to its former status.

2.6.2 Level of Effects

Negligible:

- No measurable impacts and no population-level effects.
- May cause brief behavioral reactions such as temporary avoidances of or deflections around an area.
- Localized, short-term disturbance or habitat effects experienced during one season are not anticipated to accumulate across multiple seasons.
- No mortality or detectable impacts to reproductive success or recruitment are anticipated.
- Mitigation measures are fully implemented or are not necessary.

Minor:

- Low but measurable impacts with no population-level effects.
- A small number of mortalities are unlikely but possible.
- May cause behavioral reactions such as avoidances of or deflections around an area.
- Localized, disturbance or habitat effects experienced during one season may accumulate across subsequent seasons, but not over one year.
- Mitigation measures are fully implemented or are not necessary.

Moderate:

- Mortalities or disturbances could occur, but no detectable population-level effects.
- A small number of mortalities are likely, but not to an extent resulting in detectable population level effects.
- Adverse impacts to ESA-listed species could occur.
- Widespread annual or chronic disturbances or habitat effects could persist for more than one year and up to a decade.
- Widespread implementation of mitigation measures for similar activities may be effective in reducing the level of avoidable adverse effects.
- Unmitigated or unavoidable adverse effects may be short term and widespread, or are long term and localized.

Major:

- Mortalities or disturbances occur that have detectable population-level effects.
- For marine mammals, mortality might occur at or above the estimated Potential Biological Removal (PBR) as a result of the Noticed Activities.
- For fish and benthic invertebrates, the anticipated mortality is estimated or measured in terms of tens of thousands of individuals or >20% of a local breeding population and/or >5% of a regional population, which may produce population-level effects.
- Widespread seasonal or chronic effects are cumulative and are likely to persist for more than one decade.
- Mitigation measures are implemented only for a small portion of similar impacting activities, but more widespread implementation for similar activities could be more effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are widespread and long lasting.

2.7 Sociocultural Systems

Sociocultural systems include social organization, cultural values, and institutional arrangements.

2.7.1 Significance Threshold

A disruption of social organization, cultural values, and/or institutional arrangements with a tendency towards displacement of existing social patterns.

2.7.2 Level of Effects

Negligible:

- Periodic disruption of social organization, cultural values, and/or institutional arrangements occurs without displacement of existing social patterns.

Minor:

- Disruption of social organization, cultural values, and/or institutional arrangement occurs for a period of less than one year, without a tendency toward displacement of existing social patterns.

Moderate:

- Chronic disruption of social organization, cultural values, and/or institutional arrangements occurs for a period of more than one year, without a tendency toward displacement of existing social patterns.

Major:

- Disruption of social organization, cultural values, and/or institutional arrangements with a tendency towards displacement of existing social patterns.

2.8 Subsistence

2.8.1 Significance Threshold

Adverse impacts which disrupt subsistence activities, or make subsistence resources unavailable, undesirable for use, or only available in greatly reduced numbers, for a substantial portion of a subsistence season for any community.

2.8.2 Level of Effects

Negligible: Subsistence resources could be periodically affected with no apparent effect on subsistence harvests.

Minor: Adverse impacts to subsistence activities are of an accidental and/or incidental nature and limited to a short-term.

Moderate: Adverse impacts which disrupt subsistence activities, or make subsistence resources unavailable, undesirable for use, or only available in greatly reduced numbers, for a substantial portion of a subsistence season for any community.

Major: Adverse impacts resulting in one or more important subsistence resources becoming unavailable, undesirable for use, or available only in greatly reduced numbers for any community.

2.9 Economy

The effects levels used for this analysis focus on the impacts associated with the Noticed Activities on socioeconomic systems, including employment, personal income, and revenues accruing to the local, state, and federal government.

2.9.1 Significance Threshold

Economic effects that would cause important and sweeping changes in the economic well-being of the residents or the area or region. Local employment is increased by 20% or more for at least 5 years.

2.9.2 Level of Effects

Negligible

- No measurable effects beyond short term, periodic impacts.

Minor

- Adverse impacts to the affected activity or community are avoidable with proper mitigation.
- Impacts would not disrupt the normal or routine functions of the affected activity or community. Economic systems would be impacted for a period of up to 1 year.
- Once the impacting agent is eliminated, the affected activity or community will return to a condition with no measurable effects from the Noticed Activities without any mitigation.

Moderate

- Impacts to the affected activity or community are unavoidable. Proper mitigation would reduce impacts substantially during the life of the project.
- Effects on economic systems would be unavoidable for a period longer than 1 year.
- The affected activity or community would have to adjust somewhat to account for disruptions due to impacts of the project.
- Once the impacting agent is eliminated, the affected activity or community will return to a condition with no measurable effects from the Noticed Activities if proper remedial action is taken.

Major

- Impacts to affected community are unavoidable.
- Proper mitigation would reduce impacts somewhat during the life of the project.
- The affected activity or community would experience unavoidable disruptions to a degree beyond what is normal.
- Once the effect producing agent is eliminated, the affected activity or community may retain measurable effects of the Noticed Activities indefinitely, even if remedial action is taken.

2.10 Public Health**2.10.1 Level of Effects****Negligible**

- Infrequent minor acute health problems, not requiring medical attention.
- No measurable effects on normal or routine community functions.
- No long-term consequences for Public Health or well being.

Minor

- Public Health affected, but the effects would not disrupt normal or routine community functions for more than one week.
- Effects would not occur frequently.
- Effects would not affect large numbers of individuals.
- Effects could be avoided with proper mitigation.

Moderate

- Adverse effects on Public Health occurring for brief periods of time that do not result in or incrementally contribute to deaths or long-term disabilities.
- Effects can be prevented, minimized, or reversed with proper mitigation.
- Effects could occur more frequently than minor events, but would not be frequent.

Major

- Effects on Public Health would be unavoidable and would contribute to the development of disabilities, chronic health problems, or deaths.
- Alternatively, occurrence of minor health problems with epidemic frequency.
- Effective mitigation might minimize the adverse health outcomes but would not be expected to reverse or eliminate the problem.

2.11 Environmental Justice

Executive Order 12898 requires Federal Agencies to evaluate whether proposed projects would have “disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low income populations.”

2.11.1 Significance Threshold

The significance threshold for Environmental Justice is when minority or low-income populations experience disproportionate, high adverse human health or environmental effects from the Noticed Activities. Disproportionately high adverse impacts are those impacts which exceed the significance thresholds for subsistence, sociocultural, or public health effects for minority populations or low income populations.

2.11.2 Level of Effects

The levels of effect for Environmental Justice correspond to the levels of effects for subsistence, sociocultural, or public health effects as experienced by minority populations or low income populations.

2.12 Archaeology**2.12.1 Level of Effects****Negligible**

- This category equates to No Historic Properties Affected as defined by 36 CFR 800.4(d)(1), the Code of Federal Regulations that promulgates Section 106 of the National Historic Preservation Act of 1966 as amended.

Minor

- This category equates to a finding of No Historic Properties Affected when the Agency identifies a potential conflict within an Area of Potential Effect due to the presence of a geomorphological feature and revises the plan to avoid it prior to consultation with the State Historic Preservation Officer.

Moderate

- This category equates to a finding of No Adverse Effect as defined by 36 CFR 800.5(b) when the SHPO identifies a conflict that requires a change in plan to avoid effects on an Historic Property as defined by 36 CFR 800.16(1)(1&2).

Major

- This category equates to a finding of Adverse Effect as defined by 36 CFR 800.5(C) requiring mitigation and a Memorandum of Agreement.

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APPENDIX B – 2013 SHELL ANCILLARY ACTIVITIES

CUMULATIVE EFFECTS SCENARIO

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B-1. CUMULATIVE EFFECTS DEFINED

The Council on Environmental Quality (CEQ) Regulations defines cumulative effects at 40 CFR 1508.7: Sec. 1508.7 Cumulative impact.

“Cumulative impact” is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

B-2. CUMULATIVE EFFECTS SCENARIO

The scope of this assessment includes the incremental impact from the Noticed Activities plus the aggregate effects of other activities that are known to occur or that can be reasonably expected to occur at the same time as, and in the vicinity of the Noticed Activities, and which have a potential to affect the same resources as the Noticed Activities.

B-3. IMPACT SOURCES

The main sources of impacts which could have a cumulative impact with the Noticed Activities on the resources in the Arctic OCS are: (1) marine vessel traffic, (2) aircraft traffic, (3) subsistence and other community activities, (4) scientific research activities, and (5) oil and gas-related activities.

3.1. Marine Vessel Traffic

Past marine vessel traffic has been associated with subsistence hunting, oil exploration, research, and military activities. Weather and ice have traditionally limited marine vessel traffic in the proposed exploration area to July through September.

The number of marine vessels in both the Beaufort and Chukchi Seas has increased in recent years due to advances in the technology of ice strengthening and ice breaking capacities of marine vessels, changes in ice cover and classifications of ice, increases in use of both the Northeast Passage over Russia and the Northwest Passage through Canada for commercial and tourist voyages, and increased interest in scientific and economic pursuits in the area. Reasonably foreseeable traffic in the region includes small craft involved in the fall whaling hunt at Barrow and Wainwright; USCG vessels; cargo vessels; other supply ships, tugs, and barges; cruise ships; and vessels associated with scientific endeavors. The USCG estimates that from 2008 to 2010 the number of vessels in the Arctic increased from around 100 to more than 130, and the number of transits through the Bering Strait increased from around 245 to more than 325 (USCG, 2011). The estimated number of miles of non-seismic vessel traffic in the Chukchi Sea for July through October increased from approximately 2,000 miles in 2006 to more than 11,500 miles in 2010 (Marine Exchange of Alaska, 2011). Vessel tracks from 2009 indicate vessel transits in the vicinity of Barrow and Wainwright are traditionally concentrated along the coast (Marine Exchange of Alaska, 2011).

Marine vessels are the greatest contributors of anthropogenic sound introduced to the Chukchi Sea. Sound levels and frequency characteristics of vessel sound generally are related to vessel size and speed. Larger vessels generally emit more sound than do smaller vessels. Same size class vessels travelling at higher rates of speed generally emit more sound than the same vessels travelling at lesser speeds. Vessels underway with a full load, or vessels pushing or towing loaded non-powered vessels, generate more sound than unladen vessels in a similar size class. The most common sources of marine vessel mechanical components that generate sound waves are propulsion engines, generators, bearings, pumps, and other similar components. Operations and navigation equipment, including fathometers and sonar equipment,

are also inclusive of onboard mechanical components that cumulatively create and propagate sound into the marine environment through the vessel hull. The most intense level of sound pressure introduced into the water from an underway marine vessel originates from cavitation associated with the energy of spinning propellers. Moored vessels can generate sound from the operation of engines and pumps. Cranes or other similar operational equipment performing construction activities or other work functions may transmit sound directly to the marine environment through the air-water interface or indirectly through propagation of sound waves through hulls or other support structures.

3.2. Aircraft Traffic

Air traffic has increased in recent years, mostly from increases in academic and commercial ventures, and increases in military operations. Aircraft traffic in the Arctic includes fixed wing and helicopter flights for research programs and marine mammal monitoring operations; cargo flights for supplies to villages and for commercial ventures including oil and gas related activities (such as crew changes and supply flights); flights for regional and inter-village transport of passengers; air-ambulance and search and rescue emergency flights; general aviation for the purpose of sport hunting and fishing or flightseeing activities; and multi-governmental military flights. An average of 306 commercial flights per month occurred from Wainwright airport between July and October, 2000 to 2008 (Bureau of Transportation Statistics, 2009).

3.3. Subsistence Activities and Other Community Activities

Subsistence hunting and other community activities associated with regional native villages such as Wainwright and Point Lay have persisted for millennia, and are expected to continue during the period of Noticed Activities. Marine traffic associated with subsistence hunting consists of small craft used during fishing, seal hunting, and whale hunts. Vessel traffic associated with other community activities consists primarily of supply barges traveling close to shore, within state waters. Overall, vessel traffic associated with native village activities within the Noticed Activities area is expected to be very low.

3.4. Scientific Research Activities

A considerable scientific research effort by governmental, non-governmental, and academic organizations operating from marine vessels and aircraft occurs annually in the Beaufort Sea and Chukchi Sea. The programs conducted by these organizations are generally expected to have ended for the season, or end for the season during October, but may produce cumulative impacts on resources analyzed for the Noticed Activities. Marine environmental baseline studies involve deployment of oceanographic equipment for collecting water and sediment samples, and use of nets and trawls for fish sampling and collection of phytoplankton, zooplankton, benthic invertebrates, and pelagic invertebrates. Also continuing will be observations of marine and coastal birds and marine mammals using standardized survey transect methods and passive acoustic monitoring. Metocean buoys and acoustic wave and current meters will continue to be deployed for studies of physical oceanography and climate. Previous environmental assessments, such as the environmental assessment for Shell's Beaufort Sea marine research program, describe the techniques used and the effects of these programs in detail (USDOI, BOEMRE, 2011).

Hanna Shoal Ecosystem Study (Hanna Shoal). Approximately July – October 2013, with similar proposed operating schedules through 2016. This research project will include benthic sampling, food web analysis, and contaminant measurements and focuses on the Hanna Shoal area, located between the boundary of the Chukchi Sea and Arctic Ocean waters and the Burger prospect. Water column primary and secondary production and biomass also will be measured. Cruise zooplankton data will be supplemented by data from moored zooplankton-sensing acoustic Doppler current profilers (ADCP) (units that are capable of distinguishing copepod and euphausiid biomass signatures). Moored and shipboard instruments of currents, sea ice drift, and hydrography (including geochemistry) will examine circulation and density fields. Instrument moorings will be used for long term profiling of temperature and salinity, including under ice measurements in winter. Additional oceanographic data may be obtained from other projects such as the proposed extension of the Chukchi oceanographic study. These data

include HF radar, moored ADCPs, meteorological buoys, and gliders. Formal integration with the results of other BOEM-funded projects will be made through the planned “Marine Mammal/Physical Oceanography Synthesis” to provide upper trophic components to the study. Coordination will occur with other international, NSF, NOAA, ADEC, and industry research in the Chukchi Sea.

2013 Arctic Ecological Integration Study (Arctic EIS). Also known as NSL AK-11-08, the Distribution of Fish, Crab and Lower Trophic Communities in the Chukchi Sea Lease Area.

This study proposes to develop a broader understanding of abundance and distribution of demersal and pelagic fish, crab, and lower trophic communities needed to evaluate and mitigate the effects of offshore oil and gas development. PI’s will conduct the second of a two-year field study in 2013 with fisheries and lower trophic surveys in the Chukchi Sea region to obtain baseline data on the structure and function of these ecosystems. Sampling locations range from the northeastern Bering Sea to the northwestern Chukchi Sea. The abundance of pelagic fish, jellyfish, and large zooplankton will be estimated with a multi-frequency echo-sounder and ground-truthed using pelagic gear. A series of coordinated bottom trawls will use the same survey methodology used by in the 1990/1991 Chukchi Sea Survey, and the RUSALCA surveys 2004-2008. The results will extend the time series (2004-2008) and build upon the earlier surveys (1990, 1991) of demersal fish and invertebrate communities. To further interpret the distribution of fishes and their importance as prey, water column properties (temperature, salinity, light level, chlorophyll fluorescence) will be measured at all trawl stations.

2013 Pacific Arctic Group (PAG). Ongoing activities in the general Beaufort Sea and Chukchi Sea regions include multinational efforts carried out by the Pacific Arctic Group (PAG). Organized under the International Arctic Science Committee (IASC), the PAG mission is to serve as a Pacific Arctic regional partnership to plan, coordinate, and collaborate on science activities of mutual interest to the Arctic region. Some of these activities could coincide in time and space with Shell’s proposed exploration plan activities. The Diversified Biological Observatory is a multi-national cooperative effort coordinated by the PAG, with the USA, Canada, Russia, Japan, China, and Korea contributing cruise data from past, ongoing, and planned research programs. The programmatic sampling includes continuation of collections from prior and existing research stations, including BOEM-funded projects. Focus is on four geographical research areas within the Bering Sea, Bering Strait, Chukchi Sea, and Beaufort Sea. This work includes the synthesis of studies in fields including physical oceanography, marine chemistry, biological oceanography and marine biology (primary productivity, zooplankton, phytoplankton, ice algae, epontic, pelagic, and benthic collections), and marine mammal and marine bird ecology (PAG, 2011).

Low-level Aerial Coastal Survey. This monitoring effort includes implementation of aerial surveys of coastal areas to approximately 23 mi (37 km) offshore between Point Hope and Point Barrow. These surveys will continue until exploration drilling operations in the Chukchi Sea are completed. Flight altitudes and speeds will comply with LOA and 4MP guidelines. These flights will occur in addition to activities described in the Aircraft Traffic section of this appendix. Saw-tooth flight transects were designed by placing transect start/end points every 34 mi (55 km) along the offshore boundary of this 23 mi (37 km) wide nearshore zone, and at midpoints between those points along the coast. The transect line start/end points will be shifted along both the coast and the offshore boundary for each survey based upon a randomized starting location, but overall survey distance will not vary substantially. The coastline transect will simply follow the coastline or barrier islands. “No-fly” zones around coastal villages or other hunting areas established during communications with village representatives will be in place until the end of the hunting season.

Satellite Tracking of Bowhead Whales: Habitat Use, Passive Acoustic and Environmental Monitoring (AK-12-02) This study will track the movements and document the behavior of bowhead and gray whales using satellite telemetry. Tagging operations will focus on locations nearby St. Lawrence Island during the months of April and May; Barrow during the months of May and September/October; and in Canada during July and August. Only smaller vessels used by tagging crews will be involved.

Bowhead whale vocalization rates and ambient noise levels will be documented using an acoustic tag to develop analysis of call rates relative to behavior and disturbance. Tags equipped with environmental sensors will be deployed to monitor, summarize, and transmit ambient oceanographic conditions as bowheads migrate.

Use of the Chukchi Sea by Endangered Baleen and Other Whales (Westward Extension of BOWFEST) (AK-12-07) Also known as ARCWEST, this study will involve as yet to be determined vessel or vessels that will deploy moorings within 70 km (38 M) of Chukchi Sea shoreline between Point Hope and Barrow with the intention of monitoring the occurrence and movements of large whales transiting through the area. The study will provide a full visual and acoustic survey between Dutch Harbor and the Bering Strait and Wainwright. Humpback, fin, and gray whales will be tagged in the region as practical. Cruises will be organized to extend similar research activities to those areas during years 3-4 of the study. Oceanographic surveys, including prey sampling, will be conducted in association with cruises, and will include studies of foraging ecology of bowheads using similar methods to those employed in the Beaufort Sea. Instrumented moorings may be deployed for year-around monitoring of oceanography and sound. The study will be integrated with other ongoing studies in the regions including aerial surveys, passive acoustic monitoring and oceanography. Analysis of acoustic data from new and existing recording packages will investigate the occurrence of gray, humpback, fin and bowhead whales on a year-round basis.

Aerial Surveys of Arctic Marine Mammals Project. ASAMM surveys are conducted in the western Beaufort and northeastern Chukchi Seas (68°N-72°N latitude and 140°W-169°W longitude), extending from the coast to a maximum of approximately 315 km offshore, encompassing 230,000 km². Two teams are required to cover the study area: one team, based out of Barrow, Alaska, surveys the northeastern Chukchi Sea and the other team, based out of Deadhorse, Alaska, surveys the western Beaufort Sea. Fixed-wing, twin-turbine Aero Commander aircraft were used for all surveys in 2012. These aircraft have a 5.5-hour flight endurance and are outfitted with bubble windows for downward visibility. Line-transect surveys are flown every day, weather and logistics permitting, at an altitude of 1,200 ft in the Chukchi Sea and 1,500 ft in the Beaufort Sea. The ASAMM project is conducted by the National Marine Mammal Laboratory (NMML), funded by the Bureau of Ocean Energy Management (BOEM), and permitted through the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service. Daily reports from the 2012 field season as well as previous years' reports are available on the NMML website (NMML, 2013).

USGS Walrus Tagging Research Studies. The USGS in collaboration with the USFWS and ADF&G will be working to achieve 3 separate goals in the Chukchi Sea, two of which may impact cumulative effects in the Chukchi Sea OCS. First stage of the work will be in the month of June for a walrus age composition study. This will occur onboard the Norseman II in the southern Chukchi Sea in collaboration with ADFG and USFWS. The purpose of this project is to estimate the age structure of the walrus population for input into population models. From approximately July 11 – 25 will be a study involving deployment of satellite tags on walruses from onboard the Norseman II in the Hanna Shoal region. The purpose of this work is to continue to document walrus movements and use of the northeastern Chukchi Sea in response to the loss of summer sea ice habitat. The third phase of this project is approximately September 10 – 20 for the deployment of satellite tags on walruses hauled out on land and will not impact offshore activities.

3.5. Oil and Gas Related Activities

Past oil and gas related activities in the Beaufort Sea and Chukchi Sea OCS include exploration wells, exploration seismic surveys, shallow geologic hazards surveys, geotechnical sampling programs, baseline biological studies and surveys, biological, chemical and physical oceanography monitoring programs, and

other environmental studies and sampling programs including ongoing work funded by industry for the purpose of understanding the environment within and outside the project areas.

Current reasonably foreseeable oil and gas activities in the Arctic OCS during 2013 include the current document regarding Shell's proposed ancillary activities in the Chukchi Sea and the CSESP research efforts in the region encompassing the ConocoPhillips lease areas in the Chukchi Sea. The CSESP efforts are described in greater below. These projects would concurrently occur temporally but not geographically.

Conoco Phillips Chukchi Sea Environmental Studies Program (CSESP). The existing environment in the vicinity of the Devils Paw prospect has been studied since the early 1970's. The CSESP, funded by COP, Shell, and Statoil, has voluntarily conducted and participated in comprehensive environmental studies within and near the prospect in 2008 through 2012 and will continue at least through 2013 to gather baseline data on biological, chemical, and physical resources in the proposed prospect area. These studies include biological, chemical, geological and physical oceanography work utilizing acoustics, sea floor sediment sampling, contaminant studies, plankton community assessments, benthic and pelagic invertebrate studies, marine fisheries studies, distribution and abundance of seabirds, marine mammal acoustical monitoring, observation and ecology, and marine archaeology. In addition to these baseline studies, COP will be implementing a comprehensive environmental monitoring program that encompasses the study of the before, during, and after environments that would be affected by the proposed exploration activities, utilizing methods similar to those described for the Shell monitoring program in the previous paragraph.

SAExploration, Inc. (SAE) Three Dimensional (3D) Ocean Bottom Seismic Survey. SAE plans to conduct a 3D seismic survey in the Colville River Delta area of the Alaskan Beaufort Sea during the 2013 Beaufort Sea open water season. The survey will be conducted over a period of approximately 60 days within the time period of July 1 to October 15, 2013. This time period includes all activities; mobilization, land and marine layout activities, marine data acquisition and demobilization of equipment and crews. Project operations will include state and federal shallow waters. Land transition zones could possibly include BLM state and native lands, including portions of the Oooguruk, Nikaitchuq, and Kuparuk River oil and gas production units. The proposed seismic operation will use marine ocean bottom recorders that are unlike the typical ocean bottom cable systems. The new marine node technology being used in this survey has recording nodes/geophones that do not require cables. The survey involves deploying a marine node from a vessel for placement on the ocean bottom. Marine nodes are attached by a single rope for ease of retrieval. The source of this energy will be a submerged compressed air source (air gun) towed by a vessel. After sufficient data have been recorded to allow accurate mapping of the strata, the marine nodes will be lifted onto the deck of the vessels, moved to a new location and placed onto the seabed again. By repeating the process, the volume of subsurface area can be acoustically imaged. This new technology will allow SAE to use fewer vessels, equipment and personnel and will likely have less of an environmental impact than past OBC surveys.

TGS Chukchi Sea Marine 2D Seismic Survey. TGS proposes to conduct approximately 9,600 km of 2D marine seismic surveys in Alaskan and international waters of the Chukchi Sea during the 2013 open water season (operations cannot be conducted in unbroken ice and pack ice will be avoided). The purpose of the proposed seismic program is to gather geophysical data using a 3,280 cubic inch (in³) seismic source array and an 8,100-meter (m) long hydrophone solid streamer towed by the seismic vessel. TGS plans to enter Alaskan waters sometime between July 15th and August 5th, 2013. Approximately 35 days of seismic operations are expected to occur over a period of about 45-60 days in Alaskan waters. In addition, up to 33 days of seismic operations may occur in international waters (depending on ice and weather conditions). Seismic operations are proposed to occur along pre-determined track lines at speeds of about four to five knots. Seismic operations will be conducted up to 24 hours per day as possible, except as potentially needed for shut-down mitigation for marine mammals. The full 3,280 in³ sound source will only be run during seismic acquisition operations on and near the

end and start of survey lines; during turns and transits between seismic lines, a single “mitigation” airgun (60 in³ or smaller) is proposed to be operated as a mitigation measure, as described for other NMFS-approved seismic operations in the Arctic and elsewhere.

3.6. Climate Change and Ocean Acidification

Climate change is an ongoing consideration in evaluating cumulative effects on environmental resources of the Arctic region (NOAA, 2011). It has been implicated in changing weather patterns, changes in the classification and seasonality of ice cover, ocean surface temperature regimes, and the timing and duration of phytoplankton blooms in the Chukchi Sea. These changes have been attributed to rising carbon dioxide (CO₂) levels in the atmosphere and corresponding increases in the CO₂ levels of the waters of the world’s oceans. These changes have also led to the phenomena of ocean acidification (IPCC, 2007; Royal Society, 2005). This phenomenon is often called a sister problem to climate change, because they are both attributed to human activities that are leading to increased CO₂ levels in the atmosphere. The capacity of the Arctic Ocean to uptake CO₂ is expected to increase in response to climate change (Bates and Mathis, 2009). Further, ocean acidification in high latitude seas is happening at a more advanced rate than other areas of the ocean. This is due to the loss of sea ice that increases the surface area of the Arctic seas. The resultant exposure of surface water lowers the solubility of calcium carbonate, resulting in lower saturation levels of calcium carbonate within the water that in turn leads to lower available levels of the minerals needed by shell-producing organisms, such as pteropods, foraminifers, sea urchins, and molluscs (Fabry et al., 2009; Mathis, Cross, and Bates, 2011).

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APPENDIX C – 2013 SHELL ANCILLARY ACTIVITIES

AIR QUALITY

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Air Quality

This appendix provides background information supporting the air quality assessment for this Environmental Assessment (EA) for the 2013 Shell Open Water Survey Program, and includes the details of the emission inventory. The Shell program proposes to operate a survey vessel on the OCS requiring the operation of large marine diesel propulsion and auxiliary engines that will contribute to the budget of emissions already existing within the project area. Over time, the emissions will be transported to an area by the wind having potential to result in adverse air quality effects. Thus, it is appropriate to assess the quantity of emissions expected from the survey ship and determine the degree of air quality effects.

The Noticed Activities include plans to use an ocean-going vessel that will continually traverse an area of the Chukchi Sea OCS for a period of 107 days conducting marine surveys, as illustrated in Figure C-1.

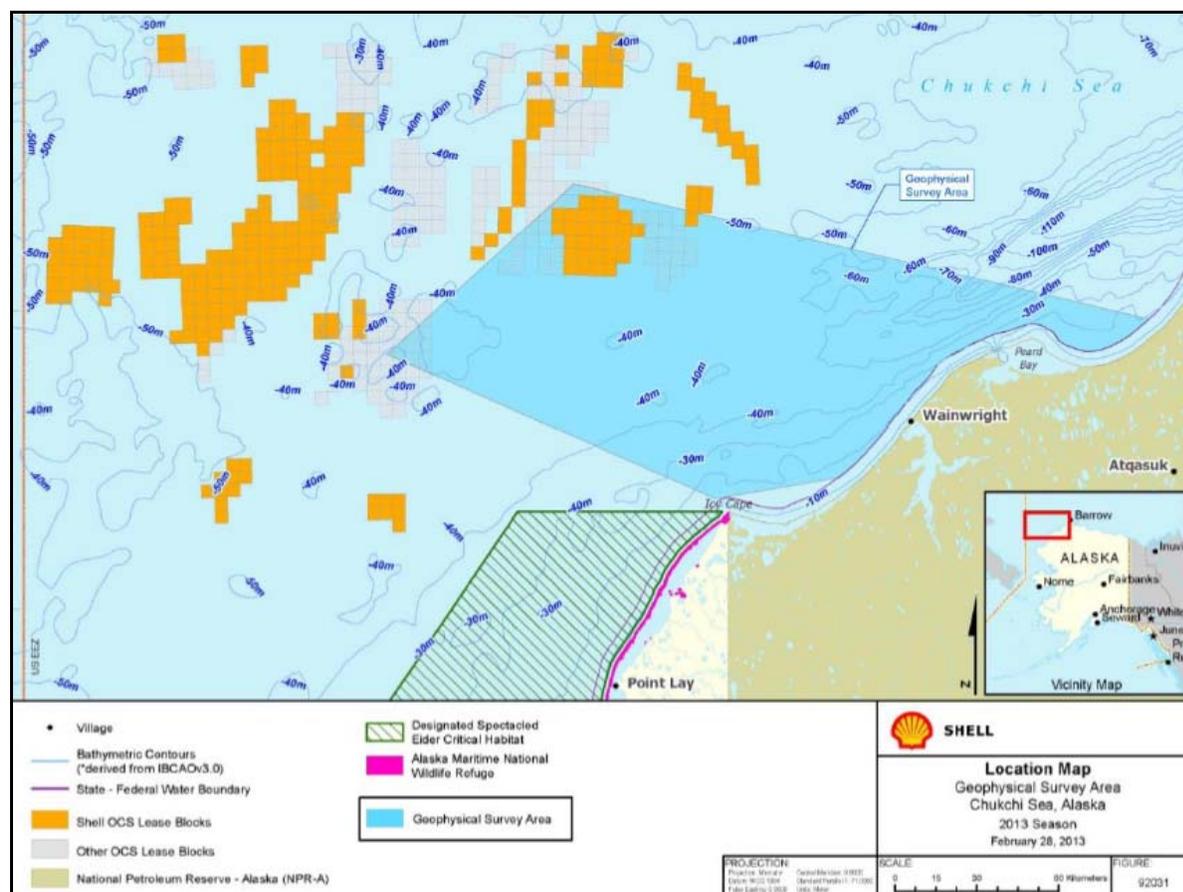


Figure C-1. Shell proposed open water marine survey program for the Chukchi Sea OCS.

The survey vessel will not be temporarily or permanently anchored or secured to the seabed in a fashion similar to drillship operations during oil and gas exploration. As such, the ships are assumed to be mobile sources throughout the survey period and categorized as marine diesel engines.

C-1. Existing Air Quality Classification on the Alaska North Slope

Impacts from pollutants emitted over the open sea are influenced predominately by wind, which is the mechanism that dilutes and disperses air pollutants in the lower atmosphere, and is the means to transport pollutants across large areas. The impacts are further influenced by the vessel itself, and whether the vessel is temporarily or permanently anchored to the seabed or traversing the open waters (mobile source). The existing air quality conditions near an onshore area are influenced primarily by the number and type of emissions sources located onshore. Winds are fairly persistent over the coastline adjacent to the Chukchi Sea where the area is flat and open to the winds of the Arctic Ocean. The mean annual wind

speed is about 6-11 miles per hour, defined on the Beaufort scale as a moderate breeze, which is sufficient to cause dispersion and diffusion of air pollutants (Wang, Wu, Cheung, and Lam, 2000; NOAA, 2010). In addition, the Arctic is characterized by episodes of strong winds and the vast open area on the North Slope provides little to slow them down (Spall, Pickart, Fratantoni, et al., 2007).

The existing air quality conditions are determined by the EPA based on data obtained from the emission monitoring equipment located near communities on the North Slope coastline. The monitored data is compared to the National Ambient Air Quality Standards (NAAQS) to determine how often and to what extent Federal standards are exceeded over a specific geographical area, throughout a specific period of time. The air quality is classified within the geographical area by the EPA based on this information. These geographical areas are referred to as air quality control regions (AQCR) and are defined by authority of the EPA.

There are four such areas defined in Alaska. The North Slope land area adjacent to the Chukchi Sea OCS is included in the Northern Alaska Intrastate AQCR (40 CFR Part 81). The northern Alaska AQCR is defined by the EPA as a clean air resource, meaning monitors are not recording pollutant concentrations high enough to consistently exceed Federal standards and the overall lack of emissions sources make it unlikely the standards are being exceeded. Thus, the area is classified as an attainment area, meaning all Federal standards for healthful air quality are being maintained over the long-term.

C-2. Regulatory Review

Outside air, referred to in a regulatory context as ambient air, becomes a concern when potential exists for harmful gases, particles, and other contaminants to build up in the lower atmosphere sufficient to cause measurable damage to human health, wildlife, or property (Monks, Granier, & Stohl, et al., 2009). Thus, the EPA established the NAAQS to serve as a benchmark for determining when the potential for harm exists. The NAAQS define the Federal numerical limits (criteria) above which concentrations of the most common air pollutants may be harmful; pollutant concentrations are expressed in terms of mass per volume, or micrograms per cubic meter of air ($\mu\text{g}/\text{m}^3$). The NAAQS are updated periodically by the EPA and are provided at <http://www.epa.gov/air/criteria.html>. The six common air pollutants for which EPA regulates pursuant to the NAAQS are:

- Carbon monoxide (CO);
- Nitrogen dioxide (NO₂);
- Sulfur dioxide (SO₂);
- Fine particulate matter (PM_{2.5}) and coarse particulate matter (PM₁₀);
- Ozone; and
- Lead.

The EPA requires controls for emission sources so that the NAAQS can be attained and maintained, and this control is implemented through local, state, and federal regulations. The regulations for controlling stationary emission sources are distinctly different from regulations applying to mobile sources. Emissions from a single stationary source affect the same downwind area on a consistent basis over a period of time due to the prevailing wind, whereas emissions from a mobile source are dispersed over a much larger area as the continuously moving source approaches and then moves farther away from a sensitive location (daycare, park, etc.). A single mobile source is less likely to cause a buildup of pollutants in a specific location sufficient to exceed the NAAQS. However, when there are scores of mobile sources concentrated in a relatively small area, such as busy roadway intersection, Federal standards are, on occasion, exceeded. Rather than limiting the number of vehicles on the roadway, the EPA requires that engines be controlled at the point of manufacture, which reduces emissions not only at the intersection, but on all the roadways wherever the vehicles are operated, thus reducing emissions on a local and regional scale, and over the long term. In a similar way, the EPA has a coordinated strategy to

focus efforts to reduce emissions from large marine diesel engines, on ships flagged in both the United States and in other countries.

Marine diesel engines, similar to those on board the *MSV Fennica*, emit primarily nitrogen oxides (NO_x), which includes NO₂, and emit SO₂, PM, and CO in lesser amounts. The pollution from marine vessels is the result of operating two types of engines on ships, main propulsion engines and auxiliary engines. The main propulsion engines on very large ships are designated as “Category 3” marine diesel engines. Category 3 engines may be more than three stories high and as long as two school buses, as shown in Figure C-2, the Finnish Wärtsilä-Sulzer RTA96-C two-stroke marine diesel engine. Auxiliary engines aboard a vessel might range in size from small portable generators to locomotive-size engines and are designated as “Category 1” or “Category 2” engines.

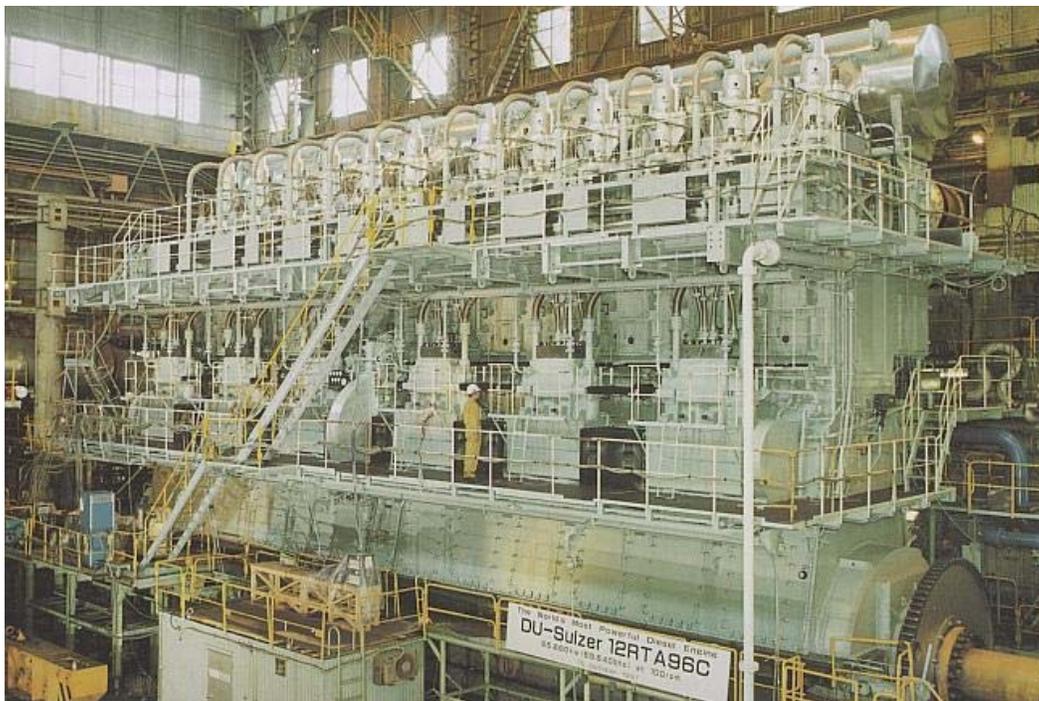


Figure C-2. Photograph of the Wärtsilä-Sulzer RTA96-C two-stroke marine diesel engine for the Emma Maersk (Denmark).

Source: Internet availability at <http://www.gizmag.com/go/3263/picture/6197/>

2.1 BOEM Air Quality Regulatory Program and Clean Air Act

The BOEM Air Quality Regulatory Program (AQR) (30 CFR Part 550 Subpart C) does not apply to operation of the *MSV Fennica* or any other emission sources or emissions resulting from implementation or operation of the program. The BOEM AQR applies only to a facility, as defined under 30 CFR 550.105, which requires the facility to be permanently or temporarily attached to the seabed for the purpose of drilling during oil and gas exploration, development, and production. The authority and jurisdiction given to BOEM under the AQR is further limited to compliance of facility emissions with the National Ambient Air Quality Standards (NAAQS), to the extent that activities authorized by the OCS Lands Act (OCSLA) significantly affect the air quality of any State; anything different is beyond the limited authority of BOEM (42 USC 1334(a)(5)). The EPA rule for the Prevention of Significant Deterioration (PSD) and the requirement for a Title V permit under the Clean Air Act, as given under 40 CFR Part 55, also are not applicable.

2.2 International Strategy to Control Pollution from Ships

U.S. Congressional and EPA reports concur that large ships similar in size to container ships, tankers, and cruise ships are not trivial contributors to regional and global air pollution (EPA, 2013b & Copeland, 2008). According to the EPA, pollution from large marine diesel engines is expected to contribute more than 2.1 million tons of NO_x emissions each year by 2030, and will increase PM_{2.5} emissions to 170,000 tons per year (EPA, 2013a). Therefore, there are national and international strategies that focus on efforts to reduce emissions from ships operating within U.S. waters. These regulations apply regardless of whether the vessels are flagged in the U.S. or other countries.

Emissions from the main propulsion engines onboard ocean-going vessels, such as the vessel proposed by Shell for the marine survey, are controlled at the point and time of manufacturer (OEM, Original Equipment Manufacturer) and must meet emission standards imposed by the International Maritime Organization (IMO). The IMO is the United Nations specialized agency with responsibility for maritime safety and security, and is concerned with the prevention of marine pollution from ships. Established in 1959, the IMO includes the United States as a signatory country and the EPA is a participant on the U.S. delegation to the IMO. In 1973, IMO adopted the MARPOL (short for marine pollution) Convention to minimize specific types of pollution of the seas.

2.2.1 MARPOL: International Convention on the Prevention of Pollution from Ships

MARPOL refers to the International Convention on the Prevention of Pollution from Ships, which established a set of agreed-upon standards and criteria (conventions) intended to minimize and prevent pollution from ships. MARPOL consists of six annexes (documents), wherein each annex describes regulations for pollution prevention at sea. Each annex is specifically dedicated to rules and regulations of a specific harmful substance. The annexes include the prevention of pollution attributed to:

- Oil from ships (Annex I in 1983);
- Noxious liquid substances in bulk (Annex II in 1983);
- Harmful substances carried by sea in packaged form (Annex III in 1992);
- Sewage pollution by ships (Annex IV in 2003);
- Garbage pollution from ships (Annex V, revised for 2013), and the
- Air pollution from ships (Annex VI revised in 2010) (IMO, 2013).

The provisions of each annex are legally binding and enforceable only when ratified by member countries (signatories) whose combined gross tonnage reflects at least half (50 percent) of the world's gross tonnage. MARPOL applies to all vessels operating in U.S. waters as well as ships operating within 200 nautical miles of the coast of North America.

2.2.2 MARPOL Revised ANNEX VI

The most recently revised version of MARPOL Annex VI (Annex VI) has been ratified by 59 countries, including the U.S., representing approximately 84 percent of the world's gross tonnage. As such, the provisions of Annex VI became legally binding and enforceable beginning July 1, 2010 (IMO, 2010). Hence, U.S. OEMs of specific marine diesel engines are required to meet the Annex VI emission standards for NO_x, and the fuel used in the engines must reduce emissions of sulfur by using Ultra Low Sulfur Diesel (ULSD) fuel. Large ships of a foreign flag country are obliged to meet the same standards when navigating within U.S. jurisdictional waters. In addition, Annex VI includes requirements for the manufacture, certification, and operation of vessels and engines, as well as fuel quality used in vessels in the waters of the U.S. Ships constructed on or after January 1, 1990 but prior to January 1, 2000, or when a major rebuild was completed during this time, must comply with the Tier 1 NO_x emission limits given in Table C-1.

Table C-1. MARPOL Annex VI NO_x Emissions Limits

Tier	Date Enforced	NO _x Limit g/kW-hr, where n=rpm		
		n < 130	130 ≤ n < 2000	n ≥ 2000
I	2000	17	45 · n ^{-0.2}	9.8
II	2011	14.4	44 · n ^{-0.23}	7.7
III	2016*	3.4	9 · n ^{-0.2}	1.96

Source: Det Norske Veritas (DNV). 2005. Marpol 73/78 Annex VI: Regulations for the prevention of Air Pollution from Ships – Technical and Operational Implications. Regulation 13 Tier I: Current Limits.

The standards apply to both main propulsion and auxiliary engines and require the engines to be operated with sulfur-limited marine fuels. The EPA issued guidance to assist operators in complying with fuel oil sulfur standards (EPA, 2012).

2.3 U.S. 1980 Act to Prevent Pollution from Ships to Implement MARPOL

The international nature of maritime shipping makes implementation and enforcement of marine engine emission standards challenging. Following ratification of Annex VI, each nation that is a signatory to the annex must enact domestic laws to implement the standards and ensure certification and compliance to the laws of the other signatory nations related to ships' emissions. Certification of ships' engines to the pollution prevention standards is the responsibility of the country where the ship is registered, referred to as the flag state. In response to this requirement, the U.S. enacted the 1980 Act to Prevent Pollution from Ships (1980 APPS). The 1980 APPS is a U.S. Federal law enacted to implement the provisions of MARPOL and the annexes. The 1980 APPS "gives the U.S. Coast Guard the authority to develop regulations and enforce MARPOL . . ." (Council on Foreign Relations, 2013). The 1980 APPS applies to all U.S. flagged ships operating anywhere in the world and, "...to all foreign flagged vessels operating in navigable waters of the U.S. or while at port under U.S. jurisdiction;" the 1980 APPS is codified at 33 USC 1901 (USLegal, 2013). The regulatory mechanism established in the 1980 APPS to implement MARPOL and its annexes is separate and distinct from the Clean Air Act and other Federal environmental laws. The provisions of the 1980 APPS do not apply to any warship, naval auxiliary, ships of the Department of the Navy, or ships operating during a time of war or a declared national emergency.

2.3.1 EPA and U.S. Coast Guard Enforcement of MARPOL

The EPA issued guidance to establish terms under which the U.S. Coast Guard (USCG) and the EPA will mutually cooperate in the implementation and enforcement of MARPOL and the annexes as implemented by the 1980 APPS. The EPA and USCG entered into a Memorandum of Understanding (MOU) on June 27, 2011, that includes inspections, investigations, and enforcement actions if a violation is detected. Efforts to ensure compliance include oversight of marine fuelling facilities, onboard compliance inspections, and reviews of records. The USCG or EPA may bring an enforcement action for a violation, which may result in criminal and/or civil liability. The memorandum is available at <http://www.epa.gov/enforcement/air/documents/policies/mobile/annexvi-mou062711.pdf> (EPA, 2012). The EPA and USGC also issued a Joint Letter to ship owners, ship operators, shipbuilders, marine diesel engine manufacturers, and marine fuel suppliers to inform them of the regulations for prevention of air pollution from ships and the requirements of Annex VI (EPA, 2012).

2.3.2 U.S. Required Certifications and Examinations

Each diesel engine subject to the 1980 APPS aboard U.S. flagged vessels must have an Engine International Air Pollution Prevention (EIAPP) certificate issued by the EPA to document the engine meets the Annex VI NO_x standard. Some vessels are also required to have an International Air Pollution Prevention Certificate (IAPP) issued by the USCG. Ship operators must also maintain records onboard documenting compliance with the emission standards and fuel requirements. Non-U.S. flagged ships are subject to examination under Port State Control while operating in U.S. waters.

C-3. MSV *Fennica* Vessel Emission Certification

The survey vessel proposed for conducting the Shell marine survey is the MSV *Fennica*, shown in Figure C-3.



Figure C-3. MSV *Fennica* to be used by Shell as a survey vessel.

Source: Arctia Offshore. MSV *Fennica* Specifications (<http://www.arctia.fi/files/FENNICA.pdf>).

The MSV *Fennica* (*Fennica*) is a combination icebreaker and subsea intervention vessel, built in 1993. Therefore, the main propulsion engines and auxiliary engines are subject to the Tier 1 emission standards established by Annex VI, as provide in Table C-1.

The original *Fennica* propulsion system was refitted replacing the four Wärtsilä Vasa 12V/16V32D engines with two azimuth thrusters. The 177-ton thrusters are driven by two ABB Strömberg AC/AC propulsion motors rated at 7,500 kW (10,058 hp), each. Together with three 1,150 kW (1542 hp) Brunvoll FU-80 LTC-2250 variable-pitch bow thrusters the azimuth thrusters allows dynamic positioning during offshore operations. In 2011, the propulsion engines on board the *Fennica* were retrofitted with Selective Catalytic Reduction (SCR) technology and urea spraying systems to substantially reduce NO_x and PM emissions (Maritime Reporter/Engineering News, 1992; Arctia Offshore, n.d.).

C-4. Emission Sources Onshore

A comprehensive statewide inventory of emission sources was prepared by the Alaska Department of Environmental Conservation (ADEC) to support the development of the State's program to control regional haze (ADEC, 2010a). The inventory accounted for all known emission sources of air pollutants across the entire state. Emission sources on the North Slope included in the inventory are:

- Area sources, such as fireplaces, asphalt paving, and gasoline distribution,
- Non-road mobile sources, such as construction equipment and snow vehicles,
- On-road mobile sources, such as passenger cars, trucks, and buses,
- Point sources, such as commercial and residential heating facilities, and
- Aviation sources, ranging from small planes to large commercial aircraft.

An inventory of projected 2018 emissions was included in the ADEC report to account for expected changes in pollutant source activity, such as population, and changes in technology, such as emission controls. The inventory shows there were relatively few emission sources located on the coastline of the

North Slope during the period of the emissions study, and there was no indication that the number of sources would be expected to increase in the foreseeable future.

C-5. Emission Inventory for Marine Diesel Engines

An emission inventory was prepared that reflects the operation of the *Fennica* together with helicopter support proposed in the Shell marine survey plan. As there would be no baseline of marine emissions associated with the no-action alternative, the emissions in the inventory should be considered the total net emission increase caused by the Proposed Action.

The emission inventory was prepared using EPA-approved methodologies provided in the Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data (EPA, 2000); and emission information available under Annex VI (DNV, 2005). The inventory includes an evaluation of the following pollutants:

- CO;
- NO_x, where emissions of NO_x are assumed to be made up entirely of NO₂;
- SO_x, where emissions of SO_x are assumed to be made up entirely of SO₂;
- Particulate matter (where emissions of PM are assumed to be made up entirely of PM₁₀)
- Volatile organic compounds (VOC)
- Carbon dioxide (CO₂)

Although a criteria pollutant, an assessment of ozone emissions was not included in the analysis. This is because ozone is not emitted directly by a source; rather ozone is formed through the secondary photochemical reaction between emissions of the precursor pollutants, NO_x and volatile organic compounds (VOC), and sunlight. As such, an inventory of NO_x and VOC emissions is provided and serves as an indicator of potential ozone development in the project area. While not a criteria pollutant, CO₂ is considered a greenhouse gas that contributes to global climate change, and is included in the inventory. Diesel fuel contains no lead, a criteria pollutant; thus, the analysis did not include an inventory of lead emissions.

Emissions from operation of the vessel's engines were calculated using the standard EPA method of applying the output power (horsepower) to the emission factors expressed as pounds per horsepower-hour (lb/hp-hr), and the number of total operating hours. The emission factors are summarized in Table C-2, which are given in the equivalent units of pounds of pollutant per engine horsepower-hour (lb/hp-hr) and kilograms of pollutant per engine kilowatt-hour (kg/kW-hr). The emission rates allow the quantity of each pollutant to be calculated based on the operating power of the vessel's engines.

The emission factors in Table C-2 were applied to the specific equipment aboard the vessel using modeling assumptions derived from the EPA Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data (EPA, 2000). The ship-specific data is summarized in Table C-3. The MSV *Fennica* is assumed to operate engines 24 hours per day, for 107 days as proposed in the survey plan, or 2,568 hours. The power output was assumed to be 72 percent to allow for lower power settings during slow cruise and maneuvering operations rather than continuous maximum cruise speed. The data from Table C-2 and Table C-3 were used to calculate total emissions from the MSV *Fennica* main and auxiliary engines, which are summarized in Table C-4, along with the emissions calculated for the Shell air quality analysis included in the Shell 2013 Environmental Report for the Open Water Survey Program. The inventory assumes a 92 percent reduction in NO_x emissions due to the use of Selective Catalytic Reduction (SCR) devices and Oxidation Catalyst (OxyCat).

The primary criteria pollutants caused by engines operated on the survey vessels are NO₂ and CO. Emissions of NO₂ are caused by the high pressures and temperatures during the combustion process. Emissions of CO are due to incomplete combustion. Ash and metallic additives in the fuel contribute to the content of PM₁₀ in the exhaust. Emissions of SO₂ are mainly linked to the sulfur content of the fuel rather than any combustion variable, and are low because of the assumed use of ULSD fuel. While

emissions of CO₂ are higher than the other pollutants, CO₂ is not considered a criteria pollutant and is not regulated for mobile sources. Emissions from the combined operation of the *Fennica* main and auxiliary engines, together with the other various sources, would not have the potential to exceed 100 tons per year for any regulatory pollutant. Therefore, the emissions are considered de minimis and not subject to any regulatory control or further analysis.

Table C- 2. Marine Diesel Engine Emission Factors

Pollutant	Emission Factors (pollutant per power unit) ^{1/}	
	lb/hp-hr	kg/kW-hr
CO	0.0055	0.003345
NO _x ^{2/}	0.0240/0.02795 ^{7/}	0.0150/0.0152 ^{7/}
PM ^{3/}	0.0007	0.000426
SO _x ^{4/}	0.00809	0.004921
VOC ^{5/}	0.000705	0.000429
CO ₂ ^{6/}	1.16	0.705590

^{1/} Based on engines without any pollution control devices or technologies.

^{2/} Assumes all NO_x are comprised of NO₂; reflects MARPOL Annex VI Tier 1 emission standards.

^{3/} Assumes all particulate matter is defined as PM₁₀.

^{4/} Assumes all SO_x in the fuel is converted to SO₂.

^{5/} Defined as total organic compounds.

^{6/} Assumes 100 percent conversion of carbon in fuel to CO₂ with 87 weight percent carbon in diesel fuel.

Table C- 3. Marine Vessel Engine Power Output Specifications

Ship	Type and Number of Engines		Power Output Rating (each)	Total Power Output (kW)
MSV <i>Fennica</i>				
	Main Engines	(2) Aquamaster US ARC 1	7500 kW	15000
	Auxiliary Engines	(2) Brunvoll FU-80 LTC-2250	1150 kW	3450

Source: Arctia Offshore. MSV *Fennica* Specifications. Available on the Internet at <http://www.nauticexpo.com/prod/stx-finland/special-vessels-icebreakers-shipyardss-30725-283628.html>

Table C- 4. Emission Inventory

Emission Sources	Emissions (tons for the total project)					
	CO	NO _x	PM ₁₀	SO _x	VOC	CO ₂
MSV <i>Fennica</i> – Main Propulsion Engines ^{1/}	20.46	24.58	6.51	4.51	3.93	21572
MSV <i>Fennica</i> - Auxiliary Engines ^{2/}	23.52	70.67	2.99	1.04	3.02	4961
Boilers	0.13	0.53	0.05	0.01	0.01	NA
Incinerator	0.61	0.18	0.43	0.15	0.18	NA
Helicopter	0.02	0.12	0.003	0.04	0.01	NA
Total	44.74	96.08	9.99	5.75	7.15	26533

Note: Emissions of CO₂ were not evaluated except for the main propulsion engines and auxiliary engines on board the MSV *Fennica*. Emission factors for other sources were not available (NA).

^{1/} Emissions based on the use of controls, including SCR and OxyCat devices that together reduce emissions of NO_x by at least 92 percent, and the use of ULSD, and compliant to MARPOL Annex VI Tier 1 emission standards.

^{2/} Emission based on compliance to MARPOL Annex VI Tier1 emission standards, assuming no after-market emission controls, but using ULSD fuel to reduce emissions of SO_x.

C-6. References

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